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POWER AND VENTILATING PLANT OF THE OLD COLONY TRUST CO., BOSTON

BY CHARLES L. HUBBARD

HEREWITH are illustrated the details of a power and ventilating plant, recently designed for the new banking building of the Old Colony Trust Co., to be erected on Court St., Boston.

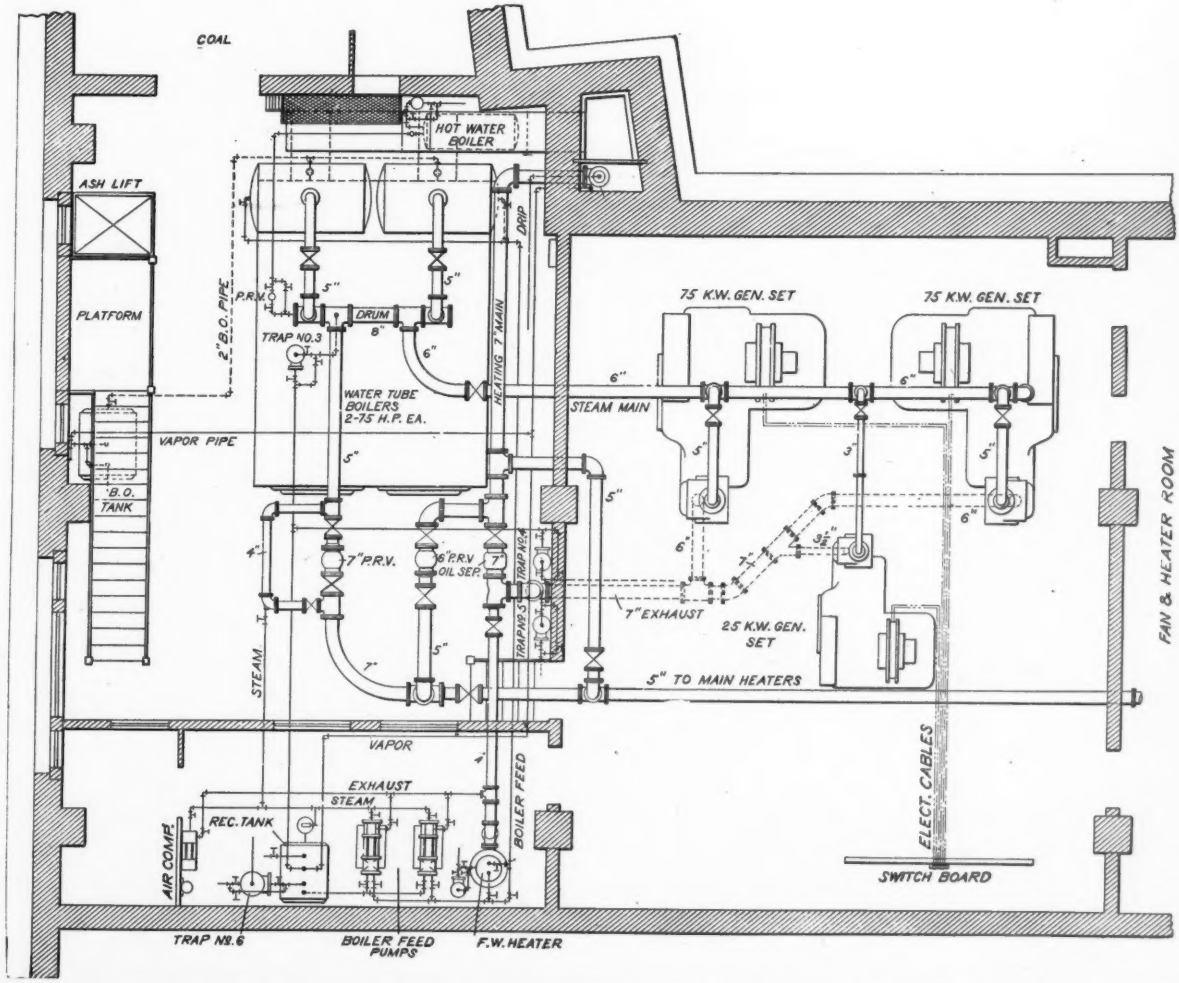

FIG. I. PLAN OF BOILER, PUMP AND ENGINE ROOMS IN OLD COLONY TRUST BUILDING

Scheme of Ventilation

The general scheme of air distribution in this building is as follows: Fresh air is drawn in through a brick downtake starting at the level of the second story. After passing through a tempering coil, washer and purifier, and secondary heater, the warm air is discharged into an underground distributing duct by means of a ¾ housing, bottom horizontal discharge fan of the regular blower type. From the underground main and branches the air passes upward through galvanized iron flues built into the outer walls of the building beside the windows, and is discharged on the various floors through wall registers at an elevation of about 7 ft.

The discharge ventilation is through similar flues leading to a shallow furred-in space at the ceiling of the upper story, where they connect with a series of horizontal ducts leading to an exhaust fan discharging outboard through the roof. This fan is of the regular exhauster type, having a 7-ft. wheel driven by a direct-connected electric motor.

In the ventilation of toilets, the fixtures are connected with airtight chambers at the rear which, in the case of the upper floors, are connected with the general ventilating system at the top of the building. The large toilet rooms in the basement are ventilated by means of a disk fan discharging into a brick uptake beside the boiler stack.

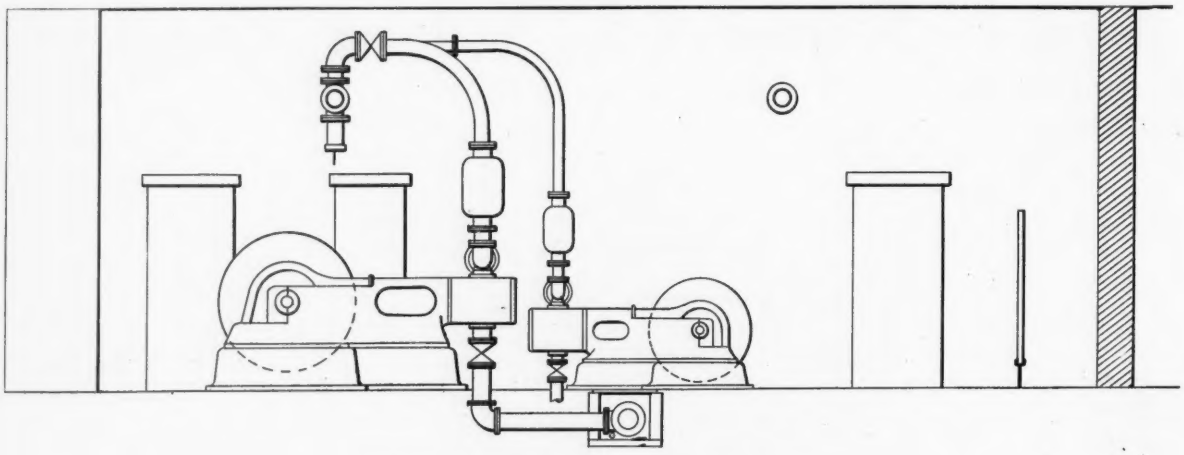

FIG. 2. ELEVATION OF ENGINES AND PIPING

Heating

The building is heated throughout by direct radiation with the exception of the public space in the main banking room and a series of small private offices at the rear of the building.

The radiators, for the most part, are placed in open recesses beneath the windows, but in special cases are concealed by a furring which is provided with grilles at top and bottom to insure a proper circulation of air. The radiators are supplied with steam through

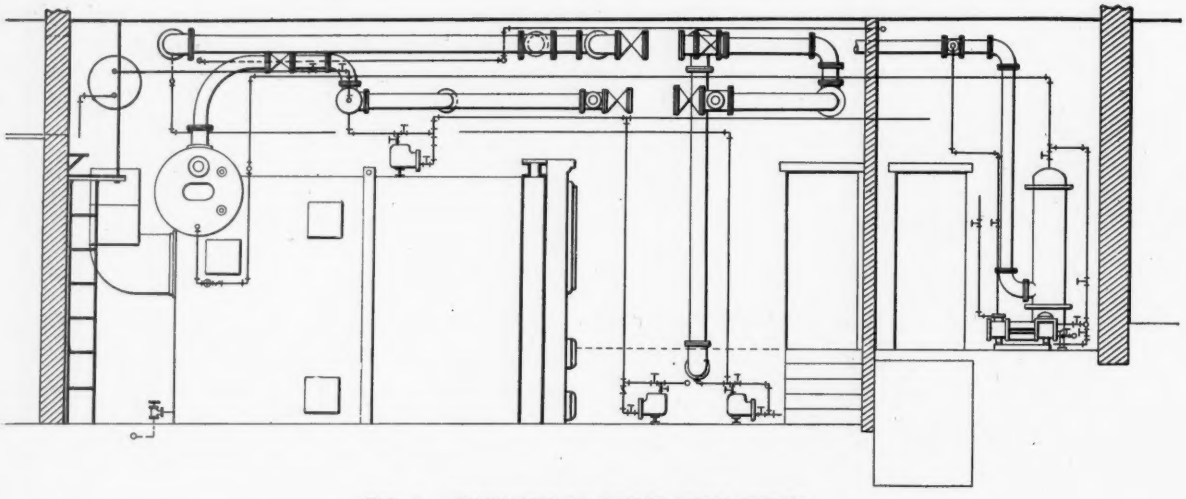

FIG. 3. ELEVATION OF BOILER ROOM PIPING

an overhead system of piping with concealed drops running down inside the air flues.

For the present, steam will be taken from a boiler plant across the street, but the plans include a complete power and heating plant which it is expected will be installed at a later date.

Power Equipment

As the proposed mechanical equipment possesses some rather interesting features, it will be described in detail. Fig. 1 shows a plan of the boiler, pump, and engine rooms. The boilers, 2 in number, are of the water-tube type, cross-drum pattern, rated at 75 hp. each. The lighting plant consists of 2 generating sets of 75 kw. each, and 1 of 25 kw. The engines are high speed, simple, noncondensing, and the generators of the direct current type.

Steam Piping

Steam from the boilers first enters an 8-in. drum, from which a 6-in. high-pressure main is carried through the engine room. This main ends in a pocket for catching the condensation and is drained to the receiving tank through a separate trap.

The connections between the main and engines are made by long sweep bends to insure flexibility, and are best shown in Fig. 2. Each engine is provided with its own separator, which is of the vertical type and placed just above the throttle valve.

Exhaust Piping

The exhaust main is carried in a trench to the boiler room, where it rises and branches, 1 branch leading to a feed-water heater located in the pump room, and the other connecting with the 7-in. heating main which runs to the top of the building. This 7-in. riser also acts as an outboard exhaust pipe during the summer time, by closing the valve in the heating branch near the top and opening the back-pressure valve which is located just above it. Before entering the heating main, the exhaust steam passes through an oil separator, as shown in Fig. 1.

Heating Piping

A 5-in. branch from the boiler drum supplies steam through a 7-in. reducing valve to the pipe leading to the main heaters in the fan room, and also through a second reducing valve, 6-in., to the heating main. There is also a 5-in. bypass between the 7-in. low-pressure heating main and the line to the main heaters.

With the arrangement shown, there are 2 reducing

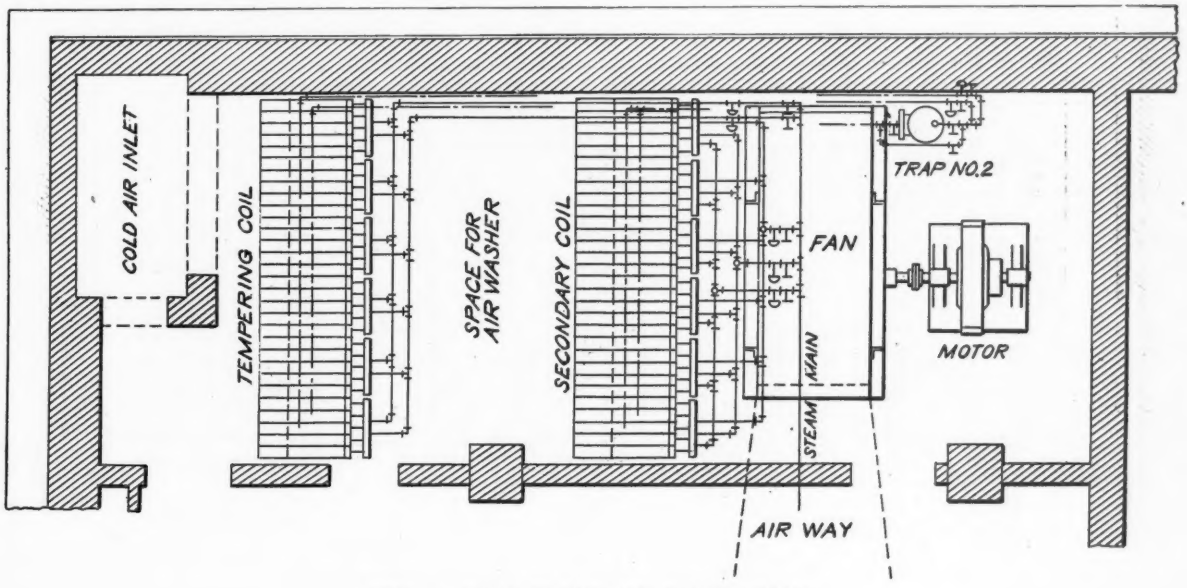

FIG. 4. PLAN OF FAN AND HEATER ROOM

valves between the boilers and low-pressure heating system which precludes any possibility of steam at boiler pressure reaching the radiators.

Should the exhaust steam at any time prove insufficient for the heating requirements, live steam will be admitted automatically through the reducing valve. On the other hand, if the exhaust is more than can be condensed in the heating system, the back-pressure valve will open and allow the surplus to flow outward.

The line to the main heaters is so valved that either live steam at any desired pressure can be used, or the supply can be taken from the low-pressure heating main at exhaust pressure. All pockets in the high-pressure piping and all separators are drained through suitable traps to the receiving tank, while the condensation from low points in the exhaust piping is trapped to the sewer.

Feed-Water System

In the pump room are a 150-hp. vertical feed-water heater, two 5¼ by 3½ by 5-in. duplex pumps, re-

ceiving tank, pump regulator, and water-line trap for the low-pressure heating system.

The air-compressors for automatic temperature control are also in this room.

The feed-water heater is of the induction type, having but a single steam connection. The feed connections from the pumps are so arranged that the water may be either passed through the heater or by-passed around it. Each pump is of sufficient size to do the whole work if necessary, and they are so connected as to be used singly or together, as may be desired. The pump regulator operates automatically upon changes in the water level in the receiving tank.

The form and location of the heating coils, with the air washer between them, is best shown in Fig. 5. The tempering coil is made up of 1-in. pipe, 4 rows deep, and is valved in 2 sections of 2 rows of pipe, each extending the full width of the heater. The secondary heater is constructed in a similar manner, except it is 6 pipes deep instead of 4, and is valved in 3 sections of 1, 2 and 3 rows of pipe respectively. Details of the secondary heater are shown in Fig. 6, in which, A, is a section illustrating the general make up, the pipe connections, and the method of supporting upon the foundation. B is a front view of a heater group 10 pipes wide, and shows the supply or steam headers in place. C is a top view of the same. D shows plan and section of 1 of the supply headers and E similar views of a return header.

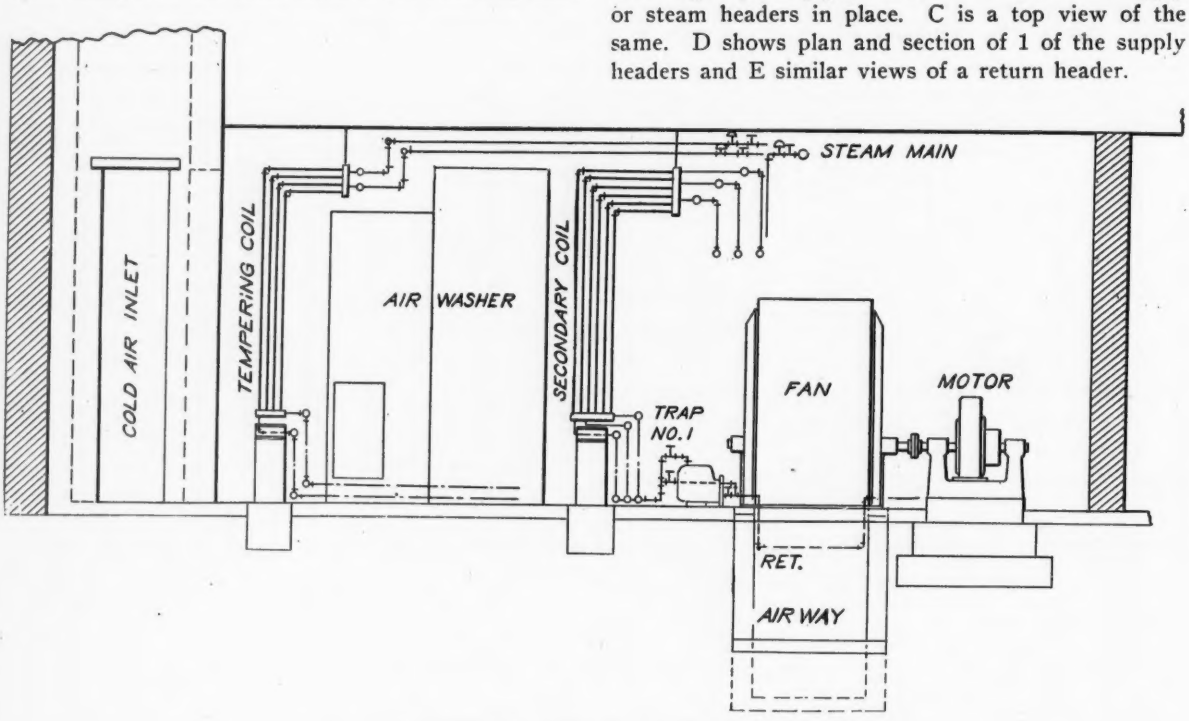

FIG. 5. LONGITUDINAL SECTION OF FAN AND HEATER ROOM

Boiler Room Arrangement

Beneath the stairs at the left is located the blowoff tank for the boilers. It is constructed of boiler plate and is supported upon cast-iron cradles. Connections for drainage and venting are of the usual arrangement.

A storage tank and boiler for heating water for toilet purposes is shown suspended at the rear of the boilers. This is provided with a steam coil connected with the boiler drum through a reducing valve. A small tank heater for summer use is provided, but not shown on the plan.

Space for coal storage is conveniently located at the rear of the boilers, with ash hoist and loading platform at the left.

Heater Details

A plan and longitudinal section of the fan and heater room, which is adjacent to the engine room, is shown in Figs. 4 and 5 respectively.

Fig. 4 shows the method of making the supply connections, each heater section being provided with a pneumatic valve, operated from a switch board by means of a 3-way cock, with the exception of one of the sections of the secondary heater, which is controlled automatically by means of a hot air thermostat placed in the airway beyond the fan. The return connections are similar to the supply.

Each heater has its own trap, which discharges into a common main leading to the receiving tank. The traps are placed at a slight elevation in order to water-seal the returns from the different sections.

Air Washer

The air washer is of standard type, made by Thomas & Smith. Water pressure for supplying the spray-heads is furnished by a small centrifugal pump driven by an electric motor. The fan is of the ¾ housing pattern and is driven by a direct connected

slow speed motor. The fan wheel is 7 ft. in diameter, and is to deliver a maximum of about 35,000 cu. ft. of air a minute.

Plans and specifications for this work were prepared under the direction of Prof. S. H. Woodbridge, of Boston.

THE NATIONAL ASSOCIATION OF COTTON MANUFACTURERS held its fall meeting at Saratoga Springs, N. Y., on Sept. 29 and 30, in the United States Hotel. The sessions were largely devoted to papers dealing with the cotton industry, but several were also presented which had to do with use of power in mills. Among the subjects were: Low-Pressure Steam Turbines, Measurements of Power and Its Transmission, Textile Mill Power Plant and the Control of Humidity.

This association was established in 1854 and has increased until it has now a thousand members distributed throughout all the cotton manufacturing districts of the country. It is for the purpose of advancing the cotton interests, and holds meetings in the spring and fall. The present officers of the association are: President. Chas. T. Plunkett, Adams, Mass.; vice president, Geo. O. Draper, Hopedale, Mass., and F. W. Hobbs, Boston; secretary and treasurer, C. J. H. Woodbury, Boston.

FIGURES COMPILED BY THE Bureau of Census and Forest Service show that the lumber cut in 1907 was the largest ever reported. This showing may be due to the fact that the report is more complete than that of any previous year, but the figure is, in round numbers, 40,000,000,000 feet of lumber. Washington, Oregon and Texas show as the largest lumber-producing states.

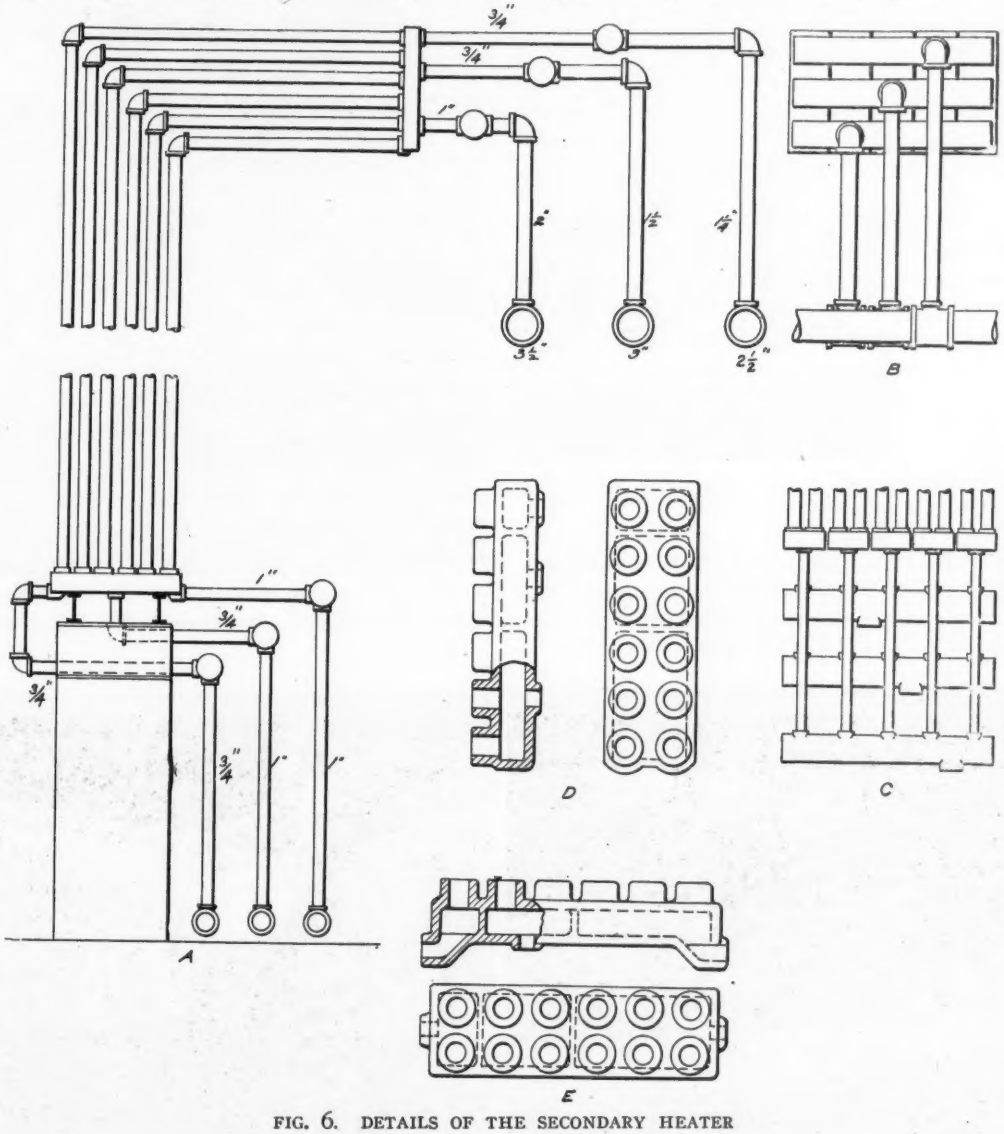

FIG. 6. DETAILS OF THE SECONDARY HEATER

WHEN PUMPING HOT WATER, a standpipe open at the upper end and extending a little above the source of supply should be connected to the suction pipe near the pump. The rising and falling of the water in this pipe

LIGHT, HEAT, POWER AND COLD FROM A SINGLE PLANT

The Lee Electric Light Co., Clarinda, Ia.

PRODUCT and byproduct both must yield a profit if the modern business plant is to give its best results, and often the utilization of resources ordinarily wasted means the difference between success and failure.

In Clarinda, a city of 4000 population, the Lee Electric Light Co. did a business of $40,000 last year, covering electric current for light and power, ice, cold storage, steam heat and pumping. There is little left which a central station can properly handle that isn't looked after. Continuous electric service, heating of business buildings and some residences, pumping the city water supply and an independent supply for the C. B. & Q. R. R. tanks, this latter being passed over the condenser coils for the ice plant before delivery, an ice plant which has been run for 3 yr. and a cold storage of 25,000 cu. ft. capacity; all these are profitable branches of this central station's industry.

By this combination of outputs the cost to consumers of all kinds of service is reduced to a very reasonable figure, which, as all are necessities and are supplied to a large number of customers accounts for a patronage which yields the remarkable income of $10 per capita for the entire population.

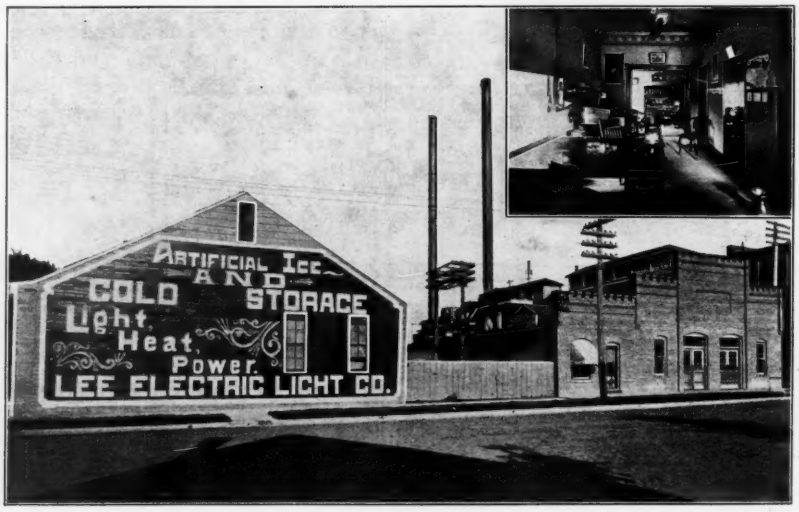

FIG. 1. LEE ELECTRIC LIGHT CO.'S PLANT, EXTERIOR AND INTERIOR OF OFFICE

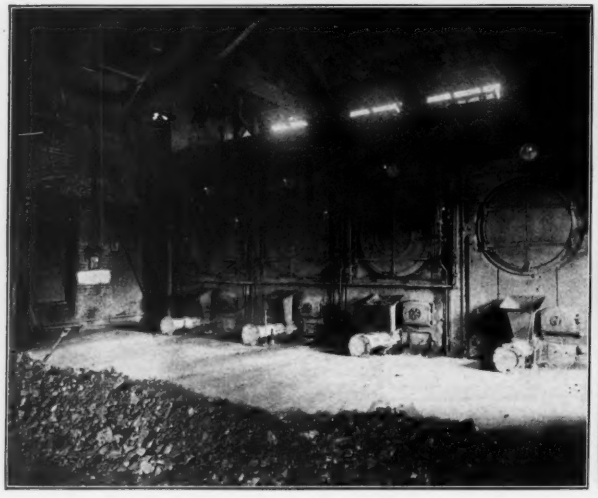

FIG. 2. BOILER ROOM WITH JONES UNDERFEED STOKER EQUIPMENT

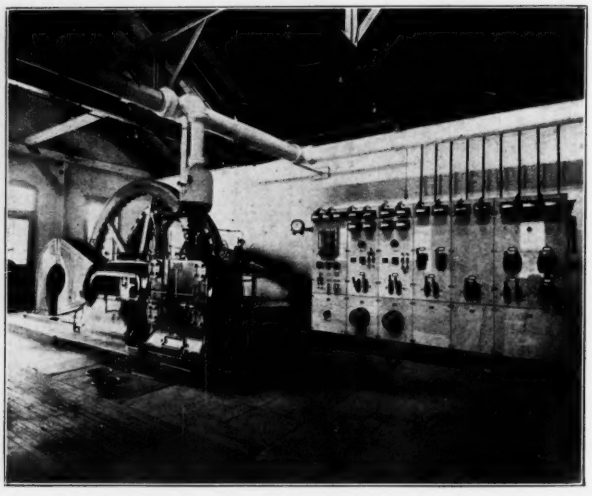

FIG. 3. MURRAY-CORLISS DIRECT CONNECTED UNIT AND SWITCHBOARD

Equipment

Steam is generated in 4 16 ft. by 60 in. return tubular boilers equipped with Jones Underfeed stokers. It passes to 3 Murray-Corliss engines, 1 16 by 30-in. at 120 r. p. m. driving a 150-kw. 2-phase 60-cyle alternating-current generator running at 2200 volts; 1 16 by 36-in. at 80 r. p. m. connected by rope drive to a 100-kw. 2-phase alternator; and 1 12 by 30-in. driving a Linde 15-ton compressor. Steam is also furnished to auxiliary units, including a 6 by 8 by 12-in. Burnham outside center packed pump for

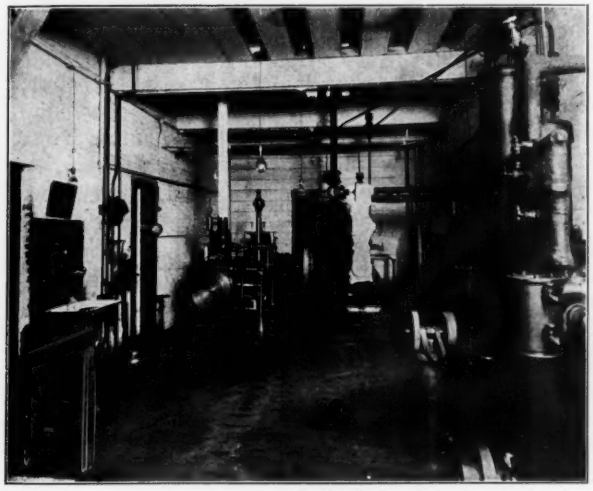

FIG. 5. REFRIGERATING MACHINERY

boiler feed, and a 4 by 5 by 6-in. Canton feed pump. The alternators, by means of a new switchboard added recently are run in parallel or singly under control of a Tirrell voltage regulator.

By means of an ingenious arrangement proposed by R. E. Lee, the general manager, heated air from the basement where the feed pumps and steam mains are located is exhausted by a blower fan and fed to the Jones stoker equipment under the boilers, thus cooling the basement and engine room and furnishing hot air to the furnaces.

The stokers, 3 of which were installed in January, 1907, and the fourth in October, have permitted the use of cheap Iowa slack where before that mine run was necessary. Much of the success of the business is due to the good judgment and resourcefulness of Mr. Lee, who kindly furnished the views for the illustrations, and who gives great credit for the smooth running of the plant to Chief Engineer John O. Olson, who has had charge of layout and installation.

LIGHT AND POWER PLANT, TWILLINGATE, NEWFOUNDLAND

Boston capital has become interested in modernizing the city of Twillingate, Newfoundland, and as the initial and basic step will establish a plant for electric light and power. This will be the third such plant in Newfoundland and basing opinion on the experience of those already in action, the enterprise is destined to be an exceedingly profitable one for those interested. Conditions at Twillingate are peculiar, as at the present time the only light is furnished by kerosene oil at 25 to 35 cents a gallon, no gas and no possibility of ever having it, thus eliminating a feature which counts so very largely in the majority of such instances in the United States.

The city has a population of above 11,000 within a radius of 4 miles and the plant will start with about 6000 lights, including 500 street lights. The charter of the Twillingate Co. is direct from the government and covers the entire district which embraces an area of about 40 miles and contains a population of over 72,000.

The plant will consist of 2 units 250 kw. steam turbines, it being not considered wise to depend upon the water power at hand in view of the recent experience of the St. John's Co. Based upon present contracts the Twillingate company shows a net profit the first year of 17 per cent on its capital.

The plant is being installed under the supervision of Mr. Frederick S. Palmer, 303 Bedford St., Boston, Mass., who is president of the company and who has associated with him several well known Boston and Newfoundland financiers. With its many natural advantages as a seaport and thus provided with power, Twillingate bids fair to develop into a city of considerable manufacturing importance.

SHOOTING WITHOUT POWDER

Engineers are familiar with the tremendous destructive force in a flywheel rim when it bursts; but it has remained for an inventor to apply this to a useful (?) purpose.

A 10-in. model of a rapid fire gun gives promise of a new departure if the full size article will work like the model. Bullets of lead are poured into a large wheel, which is revolved at high speed by means of a crank. They come out in a steady stream, and the inventor states that a gun with a 50-hp. motor will fire 50,000 shots a minute. Even at this rate, almost absolute accuracy of fire is claimed. Those who have seen the results of a flywheel wreck would certainly hesitate to charge into the mouth of a battery of guns which were offering that kind of a warm reception to casual callers.

CORRECTION NOTE

Attention has been called to the fact that in computations on heating a building, on Page 26 of the September issue, the last paragraph of the second column, by inadvertence the roof area was added in with the walls. This should not have been done. The total wall area should be 1800+3600=5400 square feet in place of 7200, and the computations following should be changed to correspond.

GAS ENGINES AND PRODUCERS

THE BUCKEYE FOUR-STROKE CYCLE GAS ENGINE

THIS term, 4 stroke cycle, signifies that 4 strokes are required to complete the action of the engine. The first stroke is occupied with drawing in a charge of air and gas is called the suction stroke. On the second this mixture is compressed and near

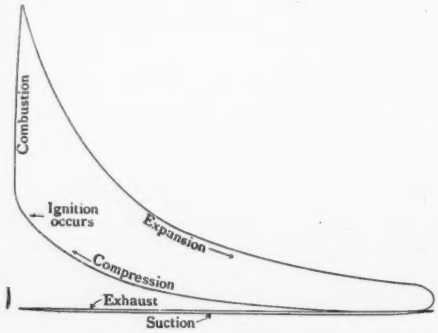

FIG. I. THEORETICAL CARD OF 4 STROKE CYCLE GAS ENGINE

the end ignition occurs. During the passage of the crankpin past the dead center the combustion or explosion takes place. During the third stroke the expansion of the hot gases is accomplished and during the fourth stroke the burned gases are exhausted from the cylinder, the series of events being as indicated in Fig. 1.

The requirements in arranging the gas engine are that the clyinder shall drain thoroughly, that the exhaust and admission valves shall be kept well apart and shall be so located that the exhaust stroke of the piston will drive out practically all the burned gas from the cylinder. These requirements are met in the Buckeye engine by placing the admission valves at the top and the exhaust valves at the bottom, as shown in Fig. 2. With the exhaust valves at the extreme bottom, oil and other deposits pass out directly through these valves. The incoming charge at the top is not mingled with the burned gases remaining near the exhaust valve in the bottom, and both exhaust and admission valves are placed so that they can be gotten at conveniently for cleaning and inspection.

For small sizes the working barrel is continuous from end to end, but the water jacket has an opening entirely around the circumference, this opening being closed by a cast-iron band drawn tightly around the cylinder. This construction allows of expansion and contraction with varying temperatures without causing strains in the structure. For larger sizes the cylinders are made in halves bolted together in the center.

The main frame of the engine is anchored firmly to the foundation but the rest of the machine is left free to move on fixed guides on cast-iron bases, as shown under the center distance piece and the slide for the rear tail rod.

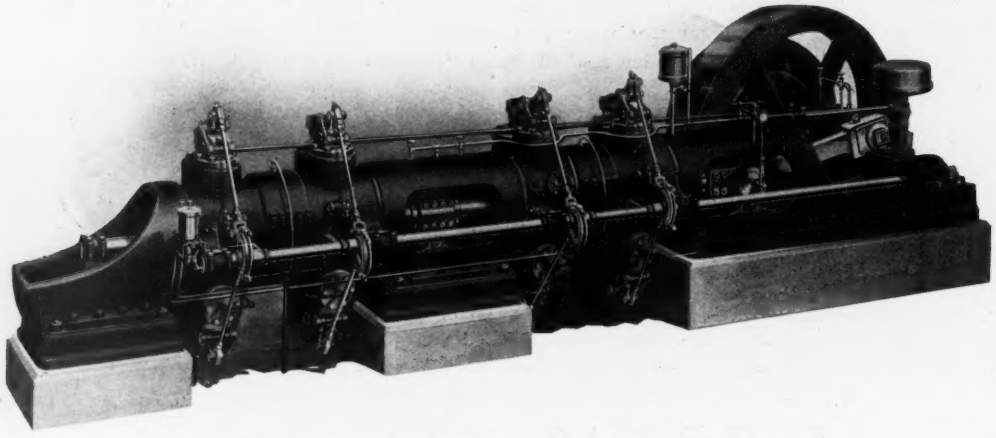

FIG. 2. BUCKEYE DOUBLE-ACTING TANDEM ENGINE

Ignition and Governing

While theoretically under perfect conditions the firing should be done on dead center and the propagation of flame instantaneous throughout the combustion chamber, actual retarding of this spread of flame by the cool metal of the cylinder walls and the imperfect mixing of gases makes it desirable to have the firing

line slope about 5 deg. forward. Compression in the Buckeye engine is kept practically uniform from maximum load to about 0.25 load. From 0.25 load down to no load the ingoing charges are slightly throttled. The valve gear has no sliding or piston valves, so that there is no sticking or clogging. All valves are of the poppet and butterfly type.

Mixing of the gas and air supply is produced as follows:

At maximum load the quality of the mixture is such as to give highest mean effective pressure with a maximum amount in volume and maximum compression. As the load falls off, the mixing apparatus automatically weakens the charge by admitting less gas until the load has decreased to about 0.25 the maximum. After this the charge is no longer weakened but the incoming charge is throttled so that a smaller weight of the mixture is taken.

The engines are designed to operate with either jump or make-and-break spark, the electromagnetic make and break system being the one recommended. In this system the current from any source, such as a storage battery or dynamos operates the igniter mechanism by means of an iron clad electromagnetic hammer, the circuit being completed and the time of ignition controlled by a timer, which is so set that the governor brings the ignition earlier on light load and later on heavy load. The timer is so arranged that all igniters can be adjusted simultaneously by hand or each igniter can be adjusted independently. In this way it is possible to keep the slope of the varying line practically the same for all loads.

Exhaust valves on all engines are water jacketed and for all engines above 11 in. diameter of cylinder the piston heads and rods are water cooled so that high compression may be used under all conditions. Engines for direct connection to electric generators are rated to allow from 15 to 25 per cent overload capacity. For belted engines an allowance of 10 per-cent is made.

The guides are bored and bolted to the cylinders, making the structure practically one single piece. The main journal bearing has babbitted quarter boxes with wedge adjustment and the crosshead is a steel casting threaded to receive the piston rod, split and clamped on the rod by means of through bolts. The crosshead shoes are steel castings with a swivel connection to the body of the crosshead, adjusted for wear by eccentric bolts.

Pistons

The pistons are carried by the crossheads, the tail rod being carried through the back cylinder head for this purpose. The pistons are appreciably smaller than the working barrel, so that no weight is carried on the cylinder walls. Tightness is secured by the use of a number of packing rings for each piston under slight tension, this having been found more serviceable than few rings under higher tension.

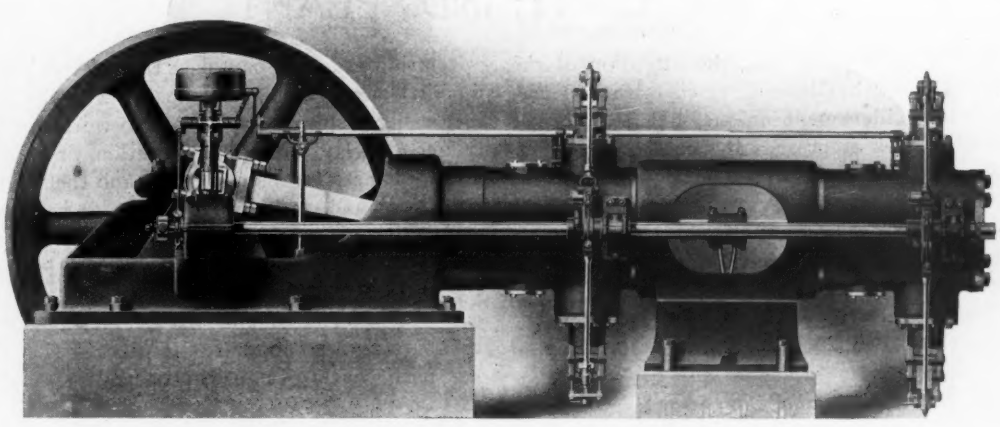

FIG. 3. SINGLE-ACTING 2-CYLINDER TANDEM BUCKEYE GAS ENGINE OF TRUNK PISTON TYPE

Crank disks are of the fan tail type, the engines being side crank in arrangement, and are properly counterweighted to balance the reciprocating parts. The cylinder heads are large, simple in construction and arranged to be water-cooled, the joint between cylinder and head being made by means of a copper strip which is fitted permanently to the head.

Valves are all driven from a lay shaft which is placed in the horizontal plane passing through the center of the engine. This shaft is driven by a set of steel gears, one of which is mounted on a drag shaft driven from the main crankpin by a universal joint, a construction which insures smooth running, even though the main crank shaft and drag shaft are

not in perfect alignment. The governor is driven from this drag shaft by beveled gears.

Cooling System

Each cylinder, cylinder head, exhaust bonnet and exhaust valve is water cooled by its own independent system of water circulation. In the double-acting tandem engines, such as shown in Fig. 2, the cooling water enters the rod through the intermediate crosshead, the stream dividing and leaving the rod at opposite ends, draining through slots in the bed and rear stub end.

Engines are started by the use of compressed air, the usual method being to use a friction clutch so that the engine is started without load. In some installations where it is necessary to do so, the engine can be started under full load and the starting valves will operate automatically until the engine begins to fire, when the compressed air is shut off.

Each engine is furnished with an indicator rig which at the same time serves to convey oil to the crosshead pin.

Single-Acting Engines

Besides the double-acting tandem engines the Buckeye Engine Co. builds single cylinder single-acting and double-acting engines and single-acting tandem engines. The single cylinder single-acting engines are built up to 300 hp. The double-acting engines are practically the same as the first cylinder of the tandem engine. The single-acting tandem is of the trunk piston type and is completely equipped with the improvements which are employed on the largest 4-cycle engines.

PROVISIONS FOR USING BLAST FURNACE GAS AT THE GARY, IND., PLANT

FOR more than 2 years past the attention of the civilized world has been directed towards Gary, Ind., where an achievement unique in the annals of industrial history is at present in process of realization. Upon the shifting sand dunes of northern Indiana, at a point where the Grand Calumet flows into Lake Michigan, 23 miles east of Chicago, there are being built, in record time, a city, a harbor and enormous steel works, the largest of their kind in the world. This is all in behalf of 1 corporation, the Indiana Steel Co., which has secured here a site of 9,000 acres, with a lake frontage of 1.75 miles, on which to erect both the mills and a residence city for its employes.

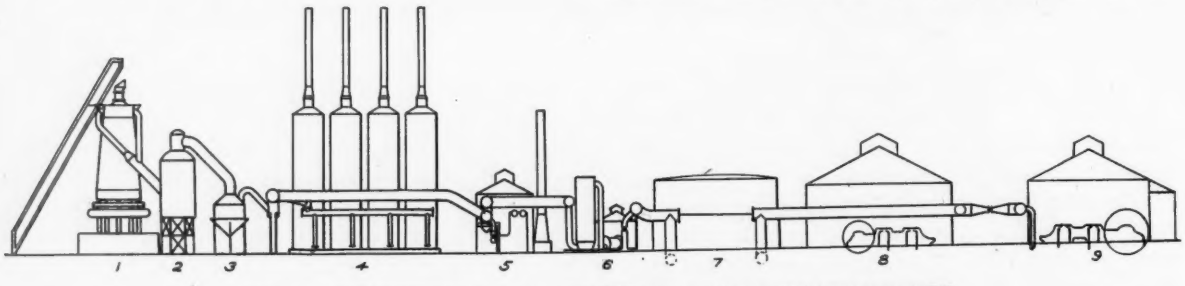

FIG. I. CONNECTIONS OF GAS ENGINES TO BLAST FURNACES AT GARY

Upon a visitor entering the plant, the first and overwhelming impression is that of magnitude; the second, resulting from close inspection, is of completeness coupled with simplicity; the third and most interesting concerns the practical elimination of waste. From these factors, as a natural resultant, comes "economy," the much-sought necessity of the present industrial world. Here it has been worked out with mathematical certainty.

During a decade or 2 past the relative cost of producing iron and steel, as compared with the constantly increasing scales of wages paid to workmen, has been reduced largely through substitution, first, of mechanical appliances for manual labor and then of improved machinery and methods. This change has been and is still taking place all along the line, from the stripping and removal of ore beds by steam shovels to the loading of the finished rails, plates or structural parts on cars ready for shipment. At every stage of the process, where new apparatus is used, if the machinery has been wisely designed, properly installed and efficiently operated, costs have been proportionately reduced and a final cheaper—usually better—product made possible.

Of late, however, there have come about still more important refinements in steel mill practice, due both to improved metallurgical processes and to the necessity of supplementing these by methods for utilizing the inevitable waste; which, consequently, is fast disappearing as waste and reappearing as "by products."

Power From Blast Furnace Gas

To give an idea of the manufacture of steel, it may be well to state, in explanation of what follows, some-

thing of the first steps of the process. When pig iron is to be made, coke, ore and limestone are put in layers in the blast furnaces and the fires are lighted. A powerful blast of heated air is sent through the burning mass, in order to generate the intense heat necessary to melt the ore and the limestone, or flux, into a molten mass. In the burning of the coke under a terrific forced draft, it is impossible to have consumed all of the heat energy in the coke.

Despite the best engineering skill, which is here exerted to make the resultant gas as "lean" as possible, all of the carbon in the coke cannot be made to unite with the oxygen in the blast, and, together with what is released in the burning of the limestone, it is carried away to the top of the furnace. The old way, in the early days of making iron, was to let it all escape into the atmosphere; later, a portion was caught and utilized for the generation of steam; and now the entire volume of this waste is, for the first time, to be made profitable on a large scale. Smaller installations of gas engines made by Allis-Chalmers Co. for the Illinois Steel Co. and 2 of the plants of the Carnegie Steel Co., as well as for other works separate from the Steel Corporation, have shown the complete success of the new system. Except for various auxiliary purposes and as a reserve in case the blast furnaces are shut down, steam has no place in the new mills.

As above intimated, the percentage of escaping gas to the heat units directly utilized in melting the ore and flux has been gradually reduced, thereby effecting very appreciable economy; but when the minimum as yet known has been reached, there remains enough heat in the tunnel-head gases of a 500-ton blast furnace such as the Indiana Steel Co. uses, to extract about 30 per cent for heating the stoves and still leave a tremendous volume of gas available for power, sufficient if it is put to work in the cylinders of internal combustion engines to furnish the blast, operate the steel works adjoining, for minor purposes about a blast furnace group and still have gas to fire steam reserves and other auxiliaries. The arrangement is shown in detail by the accompanying sketch. The gas engine, in this connection, is 2 to 3 times as efficient as the steam boiler and steam engine.

It has been demonstrated both by the installations mentioned and others made abroad that, with the utilization of gas engines, batteries of blast furnaces can be depended upon to develop enough power for all of the purposes above mentioned, making the entire plant, except for ore, coke and limestone, literally self-contained.

At Gary the plan calls for 16 blast furnaces of the most approved type, 8 of which are now completed or under construction. These are of standard design and need not be described in detail. The most interesting feature of the system is the link connecting them with the power station and blowing engine houses, viz.; the gas cleaning plant, which immediately adjoins the furnaces and stoves.

Cleansing the Gas

When the vast volume of dust-filled gas is blown to the tops of the blast furnaces, it passes from each, through 4 outlets, into 2 large pipes known as "downcomers," which lead into a reservoir, 30 ft. in diameter by 40 ft. high, called the "dry dust catcher." There a considerable part of the impurities settles to the bottom, and the gas passes into another large pipe, which leads upward some distance to increase the quantity of dust dropped and then turns down again, emptying into a supplementary tank 14 ft. in diameter by 25 ft. high, one of which serves each pair of furnaces. This structure not only provides an additional dust catcher but also acts as a valve, being divided into 2 compartments partially filled with water. By increasing the height of the water in either one, the furnace on that side can be cut off as desired, and there will be no back flow of gas from the mains beyond.

The 2 chambers of this tank discharge into a pipe 10 feet in diameter, which carries the gas and remaining impurities into the primary "wet" washers. There are 3 of these to each pair of furnaces and each has capacity sufficient to take care of the gas from a single furnace, thus providing a spare washer for use while 1 is being cleaned or repaired. The primary washers are cylindrical in form, with cone bottom and cone top, and are about 1/3 full of water, a proper overflow maintaining the required level. Here the gas and dust is discharged against the surface of the water from pipes with fluted edges like a petticoat and then escapes around these edges into openings from a larger main.

At this point a small percentage of the gas is diverted to special furnaces under a battery of Rust water-tube boilers used for making steam, and about 30 per cent is taken for heating the stoves. The remainder continues on to the secondary washers. First of this group are the vertical scrubbers, drums about 14 ft. in diameter by 50 ft. high. A torrent of water cascades down through it, and from near the bottom of the drum comes the stream of gas against it. Rising to the top the gas again passes on into what are known as Thiessen washers, of which there are 4 to each pair of blast furnaces. In each of these it is let between the wall of a cylinder and a revolving drum, armed with a series of paddle-like blades. A stream of water is spread into a film on the surface of the cylinder and the whirling drum throws such impurities as the gas still holds out against the water film, where they are caught and held.

From these final washers the gas is conveyed under slight pressure to the holders, each of which has 200,000 cu. ft. capacity, from which it goes, as required, to the electric power station and blowing engine houses. The water for the various processes described above is furnished by 4 large Platt Iron Works turbine pumps.

Volume of Gas Available

Sixteen blast furnaces produce about 44,900,000 cu. ft. of gas per 24 hours, equivalent, when used in gas engines, to 500,000 b. hp. Of this quantity approximately 30 per cent is taken for heating the stoves, 7.5 per cent is diverted to steam boiler furnaces, 5 per cent is consumed by various auxiliaries or lost in the process of cleansing, 12.5 per cent operates the gas-engine-driven blowers, and 45 per cent supplies the electrical power station.

tubs having a capacity to deliver 30,000 cu. ft. of free air per minute against a pressure of 18 lb. per sq. in. and so designed and proportioned that they can be operated at any pressure up to 30 lb.

These blowing tubs are of the Slick type, the patents for which are controlled in this country by Allis-Chalmers Co. By using this type an inlet valve area of 25 per cent and over is easily attainable, thus insuring that the cylinder will fill completely at any speed at which the engine is able to operate it. The

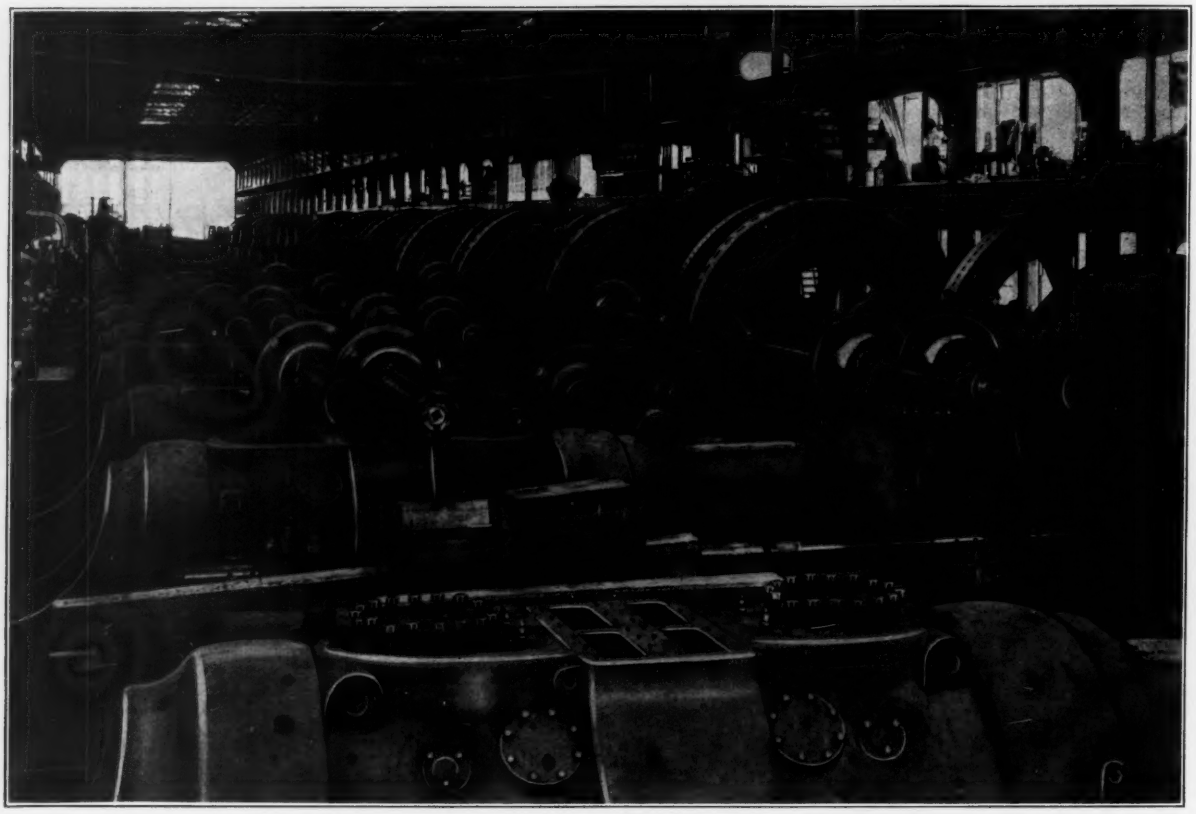

FIG. 2. INTERIOR VIEW OF POWER PLANT AT GARY. THERE ARE 3 ENGINE ROOMS LIKE THIS NOW NEARING COMPLETION; 1 FOR ELECTRICAL UNITS AND 2 FOR BLOWING ENGINES

The Blowing Engines

For the 8 furnaces thus far erected there are 2 blowing engine houses of similar construction to the power station described below. One is 600 ft. long and 104 ft. wide, and the other is of the same width but only 530 ft. long. The difference is due to the fact that the first-named house includes a central pumping and hydraulic power plant, equipped mainly by the Snow Steam Pump Works of Buffalo, N. Y. Besides gas engines each house contains 2 steam-driven Tod blowers, but, when the plant is in full operation, these will not be used.

Each of the 16 blowing engines consists of a horizontal, twin-tandem gas engine of 2,500 hp., having cylinders 42 by 54 in., and 2 direct-driven blowing gas and air cylinders are located at opposite ends of the engine frame. Eight of these engines were built by the Westinghouse Machine Co. and 8 by Allis-Chalmers Co.

Electric Generators Driven By Gas Engines

The power station, which is 966 ft. long and 105 ft. wide, with 42 23-ft. bays, is located immediately adjacent to the blowing engine houses and between the blast and open hearth furnaces. This places it advantageously for fuel supply and insures minimum lengths of transmission lines to the various departments using electric power.

In the central station are installed 17 horizontal, twin-tandem, double-acting gas engines, at a speed of 83 1/3 r. p. m., 15 of which are designed for coup-

ling to alternating-current generators and 2 to be connected to direct-current generators. The former are 25-cycle, 3-phase, 6600-volt machines, and the latter deliver current at a pressure of 250 volts. The engines have a rating of 4,000 hp. and the generators 2,000 kw. but they are capable of carrying continuously 30 per cent overload. The 17 units were built complete by Allis-Chalmers Co.

These are the largest engines in the world to operate on blast furnace gas, being practically duplicates of the units built for the Illinois Steel Co., as above mentioned, operated in parallel. The successful working of that plant insured the success of the Gary installation.

Distinctive Features of the Engines

Features of the engines which appeal most strongly to engineers who have seen them in service, are the extreme simplicity of design, the solidity of construction and the quiet operation. Maximum overloads are handled as easily and with the same freedom from vibration that characterize operation under normal load; the engines turn their centers as quietly as a slow-running Corliss machine and with apparent indifference to the rapid changes in load which, in steel mill service, they are called upon to sustain.

While the engines are, as a whole, exceptionally rigid and heavy, the weight is concentrated in the frame cylinders and tie pieces in the direct line of stresses to which an engine of this type is subjected.

In the frame is illustrated the principal difference between European and American design. This frame is designed for a side crank in place of the double-throw crank which represents standard practice abroad. The stress transmitted to the frame in a side crank engine is great, but, even in the largest size gas engines, no greater than builders have for many years, successfully provided for in steam engine practice.

The jaw, which is subjected to peculiar severe stress, is made in a form to insure maximum strength of the casting and is further strengthened by 2 steel tie bolts carried above the shaft, which are made of sufficient size to carry their proportion of the load without appreciable elongation. This construction eliminates entirely any bending stress in the frame at this point.

The engine frames weigh approximately 90 tons each; ½ of each frame is buried in the foundation, in order to raise the floor line to a point which will make the rods on the valve gear readily accessible.

The floor space occupied by 1 engine is 70 by 44 ft. and the weight approximates 1,700,000 lb. The cylinders are 44 by 54 in. stroke, the crank pins are 20 in. in diameter, the shaft is 30 in. in diameter in the bearing, and the flywheel is 23 ft. in diameter, weighing 200,000 lbs. The pistons and rods are water-cooled, water being introduced at the center and flowing forward to a discharge in the frame for the front piston and backward to a discharge in the tail guide for the rear piston, each piston having its separate supply. For dismantling or for cleansing, the rod is made in 2 parts joined at the central slide, the rear half going out at the back of the engine and the other half going out thorugh the frame, which is made open at the top for convenience.

The igniters are electrically controlled and so arranged that the time of ignition may be regulated by a single hand wheel. Direct current at 80 volts is used in the ignition system. Duplicate independent igniters are provided at each end of the cylinder to insure prompt firing of low heat valve gases and also to avoid the danger of shut down from short circuit.

The air starting device consists of a small poppet inlet air valve at each end of each cylinder, operated by the lay shaft. Air is admitted to each cylinder, in turn, at what would be the working stroke. As the high compression carried prevents the engine from stopping on the dead center, this arrangement insures the prompt starting of even a tandem engine without the use of a barring gear. These engines being twin tandem will, of course, start from any position.

The exhaust from the gas engines is conveyed to a tunnel 12 by 9 ft., located immediately outside the building and beneath the ground level. This runs the length of the building and is provided at each end with a stack 9 ft. in diameter by 92 ft. high. The same method of muffling the exhaust is provided for the blowing engine houses.

ASH FOR PILLARS IN COAL MINES

In some of the anthracite coal mines of northeastern Pennsylvania ash is being used as pillars to prevent cave-ins. Flushed into the spaces formerly occupied by coal, the ash forms a solid mass when the water drains off, capable of holding up the earth and rock above. Thus they enable the miners to "rob pillars"—to take out coal which they had been forced to leave as supports.

A mine just outside of Scranton, Pa., is near to a big boiler plant which consumes 300 tons of coal daily. Naturally, a large supply of ash is created in the fire boxes beneath the boilers. It is estimated that about 50 tons of ash a day are sent down into the mine.

Water pumped from a nearby mine is used for the flushing. Running through a wooden trough, it reaches a tunnel that passes beneath the ashpits. This tunnel slopes at a grade of ⅜-in. to the foot. At intervals the ash is shaken into it from above.

The flow of the water carries the ash to a borehole leading straight down through the ground to the mine. At the bottom are pipes leading to the worked-out places which are to be filled. Through the pipes goes the torrent of ash and water, and the ash is piled into the abandoned "breast" or gangway, while the water seeps and drains away. Gradually the pile of ash grows, until it reaches from floor to roof; then it becomes hard and firm, and the nearby pillars, containing hundreds of tons of coal, can be taken out.

ELECTRICAL MACHINERY AND APPARATUS

MAKING A LARGE DIRECT-CURRENT GENERATOR

By E. B. Raymond

LARGE generators of usual voltages have symmetrical multiple windings on their armatures. Some of the earlier designs of large direct-connected generators not only had series windings on the armature, but interpolated commutator segments as well, with the result that a large amount of testing and experimenting sometimes ensued. In the production of machines, a proper start in accuracy of engineering dimensions must, however, be followed by similar accuracy and judgment in the construction of essential parts.

The Core

This is composed of many thin sheets of steel,

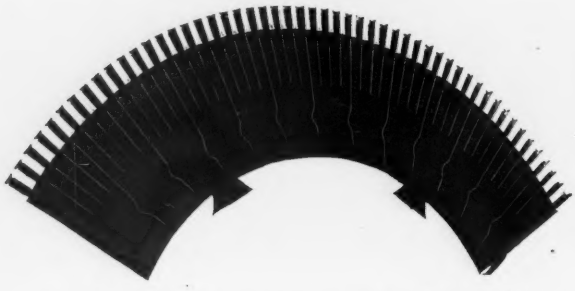

FIG. I. ARMATURE PUNCHING AND SPACE BLOCKS

each sheet having on its periphery a series of projections or teeth between which are slot shaped spaces; when the sheets are placed together in the shape of a complete core, these spaces form the slots in which the armature windings lie.

When the sheets are assembled, these teeth must coincide with perfect accuracy, so that the sides of the slots will be smooth and will not injure the insulation placed in them. Thus, in punching these slots in the sheet steel, they must be spaced very accurately and cut without burrs resulting from the action of the die, so that when piled upon each other and clamped in position between the flanges of the core, a smooth slot results. Subsequent treating of the iron must not distort the shape of the sheets, and in handling the stampings great care must be exercised to avoid bending the teeth or sheets out of shape, for if once bent, it is not possible to get them back into their original form.

Iron for use in laminated cores must have the lowest possible hysteresis loss and must remain constant, unchanged by time or any of the influences to which it is subjected during the construction and operation of the machine. Such iron cannot be purchased in this country, and it requires accurate treatment to give the commercial metal these necessary qualities.

In addition to the treatment for reducing hysteresis to a minimum amount, each sheet must be insulated from its neighbor by a material which is practically uninfluenced by heat or pressure. In the old days various forms of japan were used for this purpose; this material is now regarded as quite unsatisfactory, and a new substance is used by the General Electric Co., which, when spread upon the sheets, forms a coating only 0.0003 in. in thickness, but which has a high resistance when subjected to heat, pressure and vibration.

The assembling of all these pieces of iron (each about 0.014 in. thick), into a core weighing many tons, is a specific art, as the core must be a solid compact mass, smooth and true in the slots, of minimum hysteresis, maximum resistance between the sheets, and mechanically immovable in relation to the various parts entering into its construction. To secure these characteristics, constant watchfulness is necessary during assembly, and is rewarded by great improvements in the running temperature and life of the apparatus.

The Shaft

On the shaft are assembled the various running parts, some of which are machined to a driving fit, while others are machined to be shrunk into position; both of which operations require the highest grade of machine work with accurate gauges for checking dimensions. Where punchings are fitted directly upon the shaft, all variations in the fit of these must be closely watched, or loose punchings and injured insulation will result after the machine has been in operation for a time. The shafting department must therefore have properly trained men and efficient tools.

The Spider

Similar accuracy is necessary in the construction of the spider, as the fit between it and the shaft must be exact, as well as that between it and the punchings.

The Commutator

The art of making a commutator is even more difficult than that of making a core, for here, as in the case of the core, we have a whole composed of many parts; in addition each segment must be thoroughly insulated from its neighbors and from the commutator spider. Moreover, in service, the com-

mutator is often subjected to great variations in temperature, attacks of sparking under overload conditions, and high centrifugal strains. Nothwithstanding all this, a compact, smooth and truly round surface must always be presented to the brushes.

The insulation used in commutators is somewhat compressible and it is necessary to make allowance for this. Many departments contribute their services in producing this insulation with its characteristics of high insulating qualities, great compressive strength, correct thickness, and exact shape required by the commutator.

Commutator insulation is manufactured in sheets composed of small pieces of mica about 2 by 3 in. in size and 0.001 in. thick, pasted together with varnish until a thickness of about 0.04 in. is obtained.

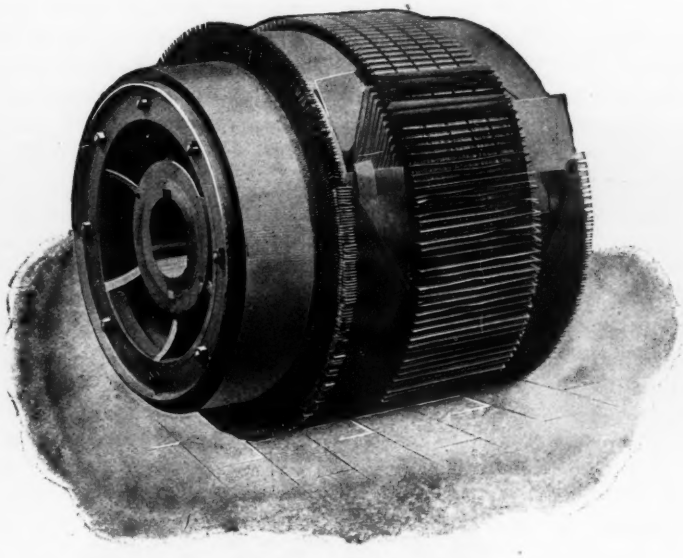

FIG. 2. ARMATURE CORE WITH WINDING PARTLY PUT ON

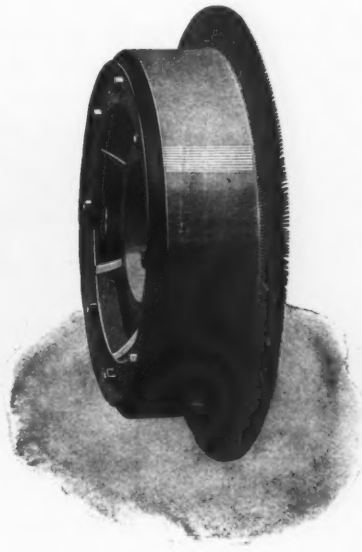

FIG. 3. COMMUTATOR

These sheets, after being pasted in this way, are heated, subjected to high pressure, and cooled while in the press; this produces a firm material quite similar to a natural sheet of mica, which is unobtainable in pieces of sufficient size in any of the mines of the world today. The sheets are then cut to the desired size and milled to the required thickness, all surface pasting material having been forced out by the very high temperature and pressure to which the sheets were submitted.

The insulation thus produced is assembled with the rough commutator bars into a cylinder, out of which wedge-shaped grooves are turned to receive the clamps which hold the segments against the action of centrifugal force. Great care must be taken when cutting these grooves and turning the surfaces, that no copper bridges over from one segment to the next, for a sliver as small as a hair is capable of destroying a whole commutator, so far as operation is concerned.

Clamping and Baking

When it is certain that no bridging over exists, mica insulating cones, built up and shaped under pressure as described, are assembled in the grooves, and the spider and clamps are placed in position. These latter are then drawn up, and the commutator bars are thus held rigidly in position, and at the same time are electrically insulated from one another and from the commutator spider.

After the parts have been clamped together, the commutators are placed in ovens and baked; the large ones at a temperature of about 194 deg. F., and the small ones at 347 deg. F. Every 4 hr. during this process an attempt is made to tighten the clamps with the insulation hot, so that any softness in the insulation can be taken up. This is done 3 or 4 times on large commutators to make sure that every segment is receiving pressure from the clamp rings, for if the insulating cones vary slightly in thickness or in hardness, and the clamp consequently bridges over 1 or more segments without putting much pressure upon them when in its final position, centrifugal force will make these segments come out slightly, causing a rough commutator surface, sparking and much trouble; hence the clamp must be tightened until every bar receives a firm pressure.

After the commutators are assembled on the machines and are in test, if any loosening of the segments or roughening of the surface occurs, as is sometimes the case, the clamps must be tightened still further, until each bar receives its full pressure; heat to soften the insulation being obtained from the current of the machine. As in all other lines of manufacture, the point at which enough has been done to accomplish a given purpose, for example, the amount

of heating and clamping necessary, must be judged by those familiar with the special line of work.

There are 2 constructions of commutators, one called the "shell type," and the other the "arch bound." In the shell type the bars are drawn down on a flange and insulated with white mica about 0.06 in. thick, and this in turn rests directly on the metal shell of the commutator spider. The bars all "bottom" hard on this insulation and at the same time the insulation between the bars is compressed; in other words a double fit is obtained—an arch fit and a shell fit. This type of construction is commonly used on big commutators.

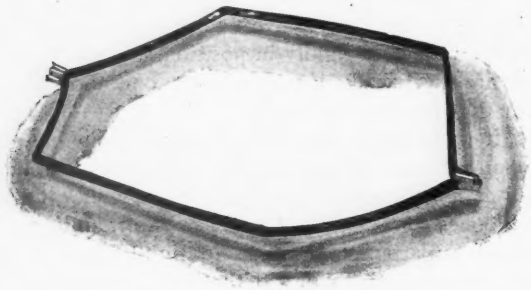

FIG. 4. ARMATURE COIL SECTIONS

On commutators up to about 25 in. in diameter, the arch construction is often used as it is somewhat cheaper, and works practically as well as the shell type up to this size. With this construction the clamps pull inward on the commutator segments until the arch of the circle prevents any further motion. In actual practice the bars are pressed inward by external means as far as they will go, and then the clamp is forced into position in the V slot so that the segments can go neither out nor in. Amber mica is used between the segments on commutators; India or white mica, which is somewhat harder, for insulating the cone clamps, as well as between the shell and the bottom of the bar in shell bound commutators.

Fittings

The fittings include brushholders, brushholder studs, cross connections and cables, terminals, etc. The particular feature here requiring accuracy of manufacture is to get the brushes all in line with the commutator segments when they are assembled in position with the brushholder studs, brackets and other fittings. Accurate jigs and fixtures are necessary for doing the machine work on these parts in order that this result shall ensue.

The Frame

Since the air-gap on electrical machinery is small and must be equal throughout the circumference of the machine, the frame, bearings, pillow blocks, etc., must all have correct positions relative one to another. Hence the machine operations on these parts must either be laid out accurately, or, if production warrants, be guided by jigs, to give the desired result.

Bearings

One of the important features of machinery is its bearings and the arrangement for insuring proper lubrication. Poor oil grooves for the distribution of oil will result in misfortune. The anchor holes for holding the babbitt in place must be kept open when the metal is poured in, and the latter must be tightened down properly. In many instances it is necessary to heat the castings to nearly the temperature of the molten babbitt to prevent "cold shut" or shrinkage cracks. Oil grooves must be located properly; oil rings must be free from rough spots, or these will cause oil throwing. In this work also, accurate gages must be used, as correctness in clearance between journal and bearing sleeve is necessary.

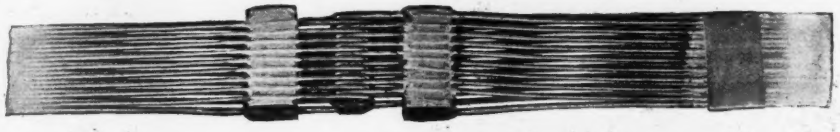

FIG. 5. SECTIONAL BINDING FOR LARGE ARMATURE

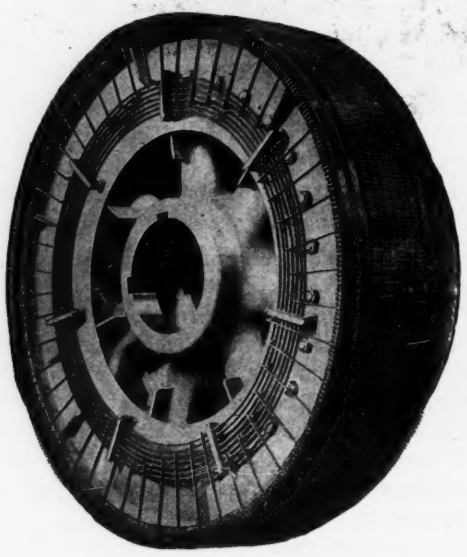

FIG. 6. REAR VIEW OF ARMATURE SHOWING EQUALIZER RINGS

Insulation and Windings of the Armature

At this point in the construction of the machine the greatest care must be exercised; first, in the production of a varnish, which is the basis of insulation; second, in placing the insulated coils in the slots. Linseed oil is today recognized as the best insulation: this is sometimes mixed with a gum, boiled down to the proper consistency and other materials added to produce a compound that may be used like a paint, and which will give a film that will stand a high voltage, and will not become brittle with age. This varnish is held to a very close standard.

Coils

All armature coils are wound on forms and are so shaped that after being placed on the armature, each coil is properly locked to its neighbor without undue pressure and without taking up undue room. The wire is wound directly into the shape it is to assume; the coil is then insulated and heated, which softens the various gums in the insulation, permitting the coil while hot to be pressed to the exact form and dimensions required. On cooling it retains this form and becomes a hard solid body, forming a coil which, when placed in its slot, is free from local pressure, bearing uniformly on the surface of the slot throughout its entire length.

A coil thus formed requires a minimum amount of space over the drawing dimension, so that the designer can reduce to a minimum the diameters of his armatures. After being thus insulated, formed and treated, the coils are ready to be placed in the armature slots, where they are held in position either by wooden wedges or by binding wire. The commutator is then put into position on its spider, or on the armature shaft, and connections are made between its segments and the armature winding, a pure tin solder being used for this purpose.

The importance previously mentioned of having the various parts fit accurately, and the necessity for exact dimensions in armature coils and slots, is illustrated by the fact that the commutator leads invariably break if any motion of the coils in the slot occurs, or of the commutator on its fit.

The armature department gives a high potential test before delivering to the testing department; first, when the coil itself is put into the slot, and second, after the armature is completely connected up. Thus a break down by high potential in test is a rare occurence on an armature.

Field Coils

These coils are insulated from their metal spools by similar materials to those used in the armature. It is customary to wind large spools with the wire in uniform layers, for under these circumstances wires have no local pressure on the insulation between the wires, as is the case if the wire is put on at random. The latter is a very much cheaper construction, but is not suitable for large machines.

Like the armature, spools are subject to a high potential test before being delivered to the test for assembly on the machine. This potential is considerably greater than the regular high potential that is applied on the machine after it has been run, and when heated by the current.

Test Room

The test room receives the various parts of the machine, spools, armature and frame, and assembles them just as they will be assembled by the customer, thus avoiding any errors in the assembling of the many parts when the machine is set up on the customer's premises. Therefore a temporary cable and brush holders or "fits" are used during test.

One of the important results to be accomplished in the test is to settle the commutator; that is, to prove that its condition is permanent in regard to the smoothness of its surface, and if running indicates that the surface is not permanent, to make it so. The first step is to get the clamps of the commutator down firm, so that when the commutator is at normal temperature, no further screwing up on the clamping rings can be done without abnormal effort. This is necessary in order that all the bars may have a direct pressure from the clamp sufficient to render any movement up or down impossible. The second step, after the clamps are properly down, is to obtain a smooth surface.

The method to follow in the first of these operations, i. e., to get the clamps down firmly, is to start the machine on a heat run, or short circuited upon itself with enough field to give full current. If roughness appears, the machine is shut down at the end of about 4 hr. and the clamp rings are tightened up. A 4-hr. heat run is chosen since the temperature during this time becomes practically constant and the consistency of the insulation is normal. If it is then found that the tightening bolts can be screw up somewhat, the machine is again started up for another heat run of similar duration, at the end of which the machine is again shut down and an attempt is once more made to tighten the bolts. When no more can be taken up on the tightening bolts, a surface is put on the commutator.—General Electric Review.

SPEAKING OF THE COUNTRY'S ANNUAL PRODUCTION of coal, Edward W. Parker, of the U. S. Geological Survey, in Mines and Minerals, estimates that by the year 2055 the United States will be using more than 2,000,000,000 tons a year. The total production in 1907 was 480,450,042 tons. Mr. Parker believes that future generations will so far develop methods of using other forces of nature that the need of coal for heat, light and power will, to a great extent, have been eliminated by the year specified. He calls attention to the fact that the exhaustion of the best fields of anthracite coal and the need for mining deeper and thinner beds increases its cost, and he doubts whether the production of anthracite will ever greatly exceed that for 1907, which was 76,000,000 long tons.

AVOIDABLE IGNITION TROUBLES

Connecting and Caring for a Dry Cell Battery

By Amos Hardy

FAULTY methods of arranging dry cells cause much avoidable trouble. The cells should not be so placed as to make possible their short circuiting because of overlapping of binding posts or of connector ends, which are usually of such size that when the

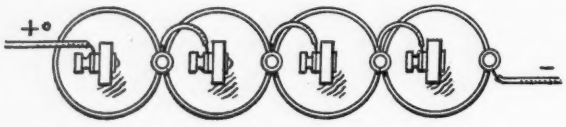

FIG. 1. BAD ARRANGEMENT OF CELLS

cells are arranged, as shown in Fig. 1, these ends touch the zinc cups of adjacent cells, making short circuiting inevitable. As shown in Figs. 2 and 3, the cells may readily be grouped in such a way as to avoid all possibility of short circuiting even when the cells are crowded closely together, with no insulation between them other than that afforded by the pasteboard covering surrounding the zinc cups.

The possibility of short circuiting may also be avoided by using thin wood or thick pasteboard separators to provide a safe clearance space between the cells. To accomplish the same purpose one design of dry cell is dented in at the binding post, while with another make the entire top is protected by a pasteboard cover through which the binding posts project.

Effect of Bad Cells

When connected up in series-parallel, it frequently

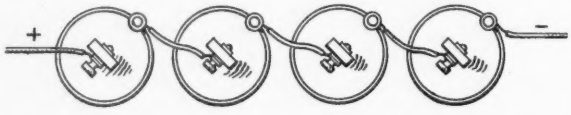

FIG. 2. PROPER ARRANGEMENT FOR SERIES GROUPING

happens that the presence of a couple of bad cells, located in different series, as shown by the shaded cells in series b and c, Fig. 3, throws most of the work of supplying current on the cells of the good series, a, thereby shortening their life of usefulness. The excessive load thrown on the good cells hastens their exhaustion to such an extent that when the presence of bad cells is suspected no time should be lost in testing all the cells of the battery and removing those found defective.

Loose Connections

Loose electrical connections are responsible for a great deal of the trouble experienced with dry cells. The binding post of the carbon plate, when held in place by a screw and nut, often becomes loose, and thus greatly increases the resistance of the circuit. For this reason the carbon-plate terminals should be tested and tightened if necessary, before cells are put into active service.

With a number of dry cells crowded closely together, the importance of having proper connecting wires can hardly be overestimated, for the straying end of a broken, though well insulated wire, will often put a battery out of service. In making plain wire battery connections it is always advisable to use good-size copper wire, at least No. 18 B. & S. gage, having a double insulation and waxed to prevent the insulation from becoming loose at the ends. Care must be exercised in removing the insulation from the ends of the wire, for a slight nick made by the knife or pliers is often sufficient to cause a future break. A better job can be had by using flexible rubber covered and

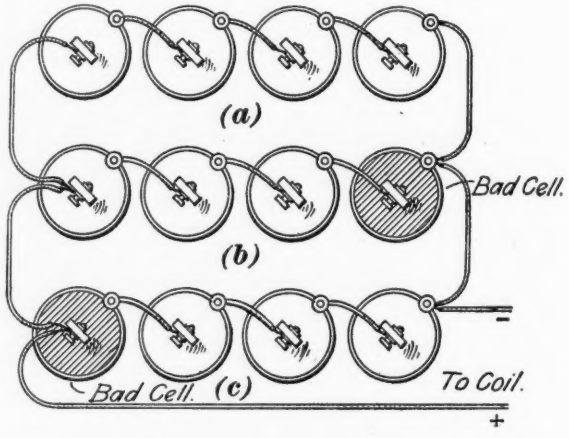

FIG. 3. GOOD METHOD FOR SERIES-PARALLEL-GROUPING

braided wire like "lamp cord," the strands of fine wire being soldered together solid at the ends to prevent poor contact through spreading, and to permit of tightening the binding nut so as to hold the end secure.

Binding Post Connection

When ordinary insulated wire is used for making battery connections it is commonly wound around the binding post and crossed, as shown in Fig. 4 (c). This is an improper method because, when the terminal nut is tightened, the wire will be cut part way through at the point of crossing a, where it may subsequently break under a comparatively small stress. Care should also be exercised not to put the wire around the binding post, as shown in Fig. 4 (b), because the operation of tightening the terminal nut will tend to move the end of the wire b away from the post, thereby opening the loop and lessening the effective grip of the nut to such an extent that the wire is shaken loose by comparatively slight vibration.

The correct method of attaching the wire is shown

in Fig. 4 (a), the wire being wound around the binding post so that in tightening the binding nut the loop will remain closed, the free end of the wire being kept in place by the nut instead of being forced away from the post by it. As shown, the insulation of the wire should come close to the binding post and the end of the wire should be cut off at c so as not to project beyond the edge of the binding nut.

Size of Battery

Another cause of avoidable trouble with dry cells is the use of too small a battery, the effect of which is a pronounced loss in the useful life of the cells. The installation of too small a battery is frequently due to ignorance of the fact that there is considerable difference between the voltage of cells when inactive and when in service, furnishing current to the spark coil. Dry cell batteries should be tested while in service, but, as a rule, it is assumed that the voltage shown by the voltmeter when each cell is tested separately, represents the voltage that will be obtained when current is being supplied to the coil, which should always be adjusted so as to require the minimum of current to produce the right kind of spark.

FIG. 4. BINDING POST CONNECTIONS

If the voltage of a battery, while in active service, is inadequate to insure the production of a satisfactory spark with a minimum rate of current consumption, it is false economy to depend on a few cells to make up for the deficiency in voltage through an increase of current consumption, which rapidly exhausts the cells. It is much better to have the service voltage of the battery in excess of that for which the spark coil may have been wound, because a coil giving indifferent results when adjusted for a comparatively high rate of current flow from a few cells, would give efficient service with a minimum consumption of current when adjusted for use with a battery generating the proper voltage when in active service; hence, when partly exhausted dry cells are employed for ignition purposes, it is important to use as many as may be required to generate a service voltage slightly in excess of that for which the coil was originally designed.

For example, with a 4-volt coil at least 6 used cells showing, say, 0.8 volt and 10 amperes under test, should be used. Moreover, when the service voltage is adequate and constantly maintained so, the coil will require little if any adjustment, there will be no arcing at the vibrator points, and there will be no liklihood of trouble from internal short circuiting of the coil.

Grounding

In grounding an ignition battery, that is, in making a connection with some part of the engine to provide a path or circuit for the return current, it should be borne in mind that the greater the distance between the point of action and the point of attachment of the negative battery wire the greater will be the resistance to overcome. Hence, to prevent unnecessary waste by forcing the current to overcome resistance due to rust, low conductivity of dissimilar conducting materials, poor contacts between metallic surfaces, etc., the negative battery wire should be grounded at a point as close as possible to the spark plugs, thereby providing a direct path for the return current through a medium of high conductivity.

"SMASHING" INCANDESCENT LAMPS

Lamps are so good now-a-days that with decent voltage regulation, so that they are not continually overheated, they will burn 750 to 1000 hr. before the filament breaks. If you burn it that long, it becomes of course, self "smashing," i. e. puts itself out of business.

It isn't good business, though, to do this. After a lamp has burned awhile the carbon from the filament begins to blacken the bulb by depositing on the inside surface of the glass. That cuts down the light from the lamp and leads to a waste of power. Just how much of a coating may be allowed before "smashing" the lamp or taking it out of service depends on the place to be lighted and the cost of coal and lamps, but the economical limit of burning comes long before the filament breaks. A lamp shouldn't go beyond the time when the carbon blackening becomes prominent. The fuel saved and, especially in decorative lighting, the added attractiveness more than offset the slight extra cost in lamps.

SCALE IN THE FURNACE

In a certain plant not a thousand miles from the Windy City is a battery of water-tube boilers of horizontal type in which Illinois coal is burned with natural draft of about 0.75 in. Inside the boilers seem happy and contented, but on the outside of the tubes a substance collects extending from top to bottom of the several sections of the boiler and looking like clinker. When the fire doors are open the stuff can be seen to drop down and collect on the bridge wall, making that burn out faster.

It collects fast, so that in 5 to 6 weeks it stops the draft, and the boiler has to be shut down, while a man chips the stuff off the tubes. Now boys, what's the why of this, and have any of the rest of you got a like yarn to tell?

DURING THE LAST 6 years, the amount of sawed lumber exported from the United States has increased 12 per cent and the price over 50 per cent.

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BOILER CAPACITY AND EFFICIENCY

It has been almost a tradition, apparently based on facts, that a boiler run at a low power or a low capacity had a higher efficiency than when forced. But some tests made at high capacity within the last 2 years have seemed to show that forcing the boiler in those tests had greatly increased the capacity without materially affecting the efficiency. The results seemed contradictory and confusing. From a study of the action of the heating surface of boiler tubes and of data from the tests of the U. S. Geological Survey testing plant, Lloyd R. Stowe has deduced an explanation which seems reasonable. The furnace conditions which determine the heat absorbed per hour by a boiler are temperature and pounds of gas used per hour. A small flow of gas at high temperature may carry the same amount of heat as a large flow of gas at low temperature. Hence, a given capacity of a boiler may be developed by sending but a small amount of air through the furnace and keeping it at high temperature, or by using more air and having the temperature lower.

Finding the efficiency at different temperatures of furnace for a given capacity, and comparing these for different capacities, he has found that for temperatures below 3300 deg. F. the efficiency of that particular boiler increases as the capacity decreases. At 3300 deg. the efficiency is constant regardless of the power that the boiler is developing, and above that temperature the efficiency increases as the power increases. This is explained by the fact that when a large flow of gas is used at a low temperature, the time of contact is less with the boiler surface, and for temperatures below 3300 the effectiveness of the boiler heating surface due to the contact with a greater amount of gas does not compensate for the lessened time of contact. At 3300 deg. the 2 effects are balanced, and above 3300 deg. the effectiveness of the heating surface more than makes up for the shortening of the time of contact.

It is likely that the critical temperature at which the furnace must be run in order to get the same efficiency regardless of the power developed will be found to vary with different boilers and settings, but the law is established, and will have an important effect on boiler design and operation. Where a boiler has to carry varying load, it is evident that the temperature of the furnace for constant efficiency should be determined and the boiler so designed and operated that it will be run with that furnace temperature. Where the load is constant, the best efficiency is secured by so operating as to get the highest possible furnace temperature.

FOREST DESTRUCTION

Accurate estimate is to be made by the Forest Service of the standing timber left in the United States. Guesses have ranged from 822,682 million to 2000 billion board feet, a wide variation, and some

accurate knowledge is needed in order to compute how long our timber supplies will last. The annual consumption of wood is fairly well known and is about 100 billion board feet.

From these figures the exhaustion of the timber supply may come in from 23 to 33 yr.

In the face of these facts, which it is the purpose of the census to verify, the attitude of corporations such as the Colorado Fuel & Iron Co. at the recent irrigation congress seeking to restrict the power and nullify the work done by the Forest Service and Chief Forester Pinchot is deserving of condemnation. The movement to conserve the natural resources of the country and turn them to the benefit of the whole people and the work that has actually been accomplished in this direction are of the greatest value and any step backward is simply a step toward private greed and graft at public expense.

EDITORIAL CHAT

Oil Economy

Many fellows in charge of plants, even plants of considerable size, hang to the old oil cup filled by hand and with feed cut down as low as it can be—save the last drop this side of a hot bearing. They stick to this idea as if they were married to it in a state where there are no divorce laws. Yet it's not so hard to get up a system of filling the cups from an overhead tank by gravity, filling the tank by compressed air or a hand force pump and keeping the bearings flooded with oil.

Is it worth while? Well, that depends on how much you like to take chances on a stuck bearing and how dearly you love to mess with an oil can. You save worry, you save oil, you save friction loss and your bearings are safe; but if you like the oil can of our daddies, there's no use arguing the question, only don't kick if you have to work all Sunday to get a bearing rebabbitted, because you won't put this central oiling system up to the boss so that he can see where it will help.

Of course you must have a good filter, and go get a good one, which will rejuvenate the oil right. Then you'll use less oil with flooded bearings than you do now with just a wee drop too few for safety.

You want, of course, a good set of oil guards, or with flooded bearings the oil may spatter; but you ought to have those anyway to safeguard the men about the plant from being caught or struck by the machinery.

Some bosses don't want to make the outlay, "just to give the engineer more loafing time." Such a boss doesn't deserve a progressive engineer who reads and studies and tries to keep his plant up. What he ought to have is a has-been who is content to sleep on so long as the wagon stays in a rut.

Some engineers are scared to put in a central oiling system for fear that they will seem to have more time and be put at some work about the mill. A chief needs time to think and plan as much as any other man in charge of affairs. And he needs time to read to keep himself in touch with progress.

Most owners will see this if it is put to them right. Some are bull headed and won't. There's no use trying to progress in their plants. But there are so many advantages in central oiling that it's worth trying for in every plant.

Circular Mils

That title sounds like a grist mill or a coffee mill or a rolling mill; but it's just plain wire for electric circuits. The current that will go through a wire and, the resistance that the wire offers depend on the area, which is proportional to the square of the diameter. It isn't handy to figure squares in your head and wires are mean diameters to figure anyway; so the wise men who get up such things allowed that a wire one thousandth (0.001) inch in diameter should have an area of a "circular mil." Mil means one thousandth. Then a wire of any diameter would have an area in circular mils equal to its diameter in mils squared; a wire 0.1 diameter is 100 mils and its area $100 \times 100 =$ 10,000 circular mils.

This works in handy in a lot of ways; for instance, the resistance of a copper mil-foot, i. e., a wire a mil in diameter and a foot long is 10.5 ohms; for a circuit a foot long, having 2 feet of wire, it would be 21 ohms. Then to get the resistance of any circuit, multiply the length in feet by 21 and divide by the diameter of the wire in mils. And, of course, to get the drop over any circuit multiply this resistance by the current carried.

Now to turn it over, when you know the length of circuit, the current and the drop allowed and want to know the wire to use, multiply the length by the current and by 21 and divide by the drop. The answer will be the circular mils of the right wire to use, and to get the diameter of the wire in mils, just extract the square root.

You have to look out for one thing though; if the circuit is short or the drop allowed is large, the wire may be too small to meet the Underwriters' rules, so you have to ask them or look up the carrying capacity in their tables.

Just to show how; what size wire to carry 100 amperes 500 feet with 3 volts drop?

$500 \times 100 \times 21 \div 3 = 350{,}000$ circular mils. The square root is 591.6 mils or 0.5916 in. diameter. As the Underwriters give 270 amperes safe for 300,000 circular mils, this wire will do.

R. D. Wood & Co., Camden, N. J., has secured the contract for a pumping engine for Trenton, N. J. This new machine will be of the vertical, triple-expansion crank and flywheel type, with a daily capacity of 20,000,000 gal., will stand 45 ft. high, 22 by 33 ft. on the floor. Each flywheel will weigh 16 tons, 2 wheels being provided to steady the 3 steam cylinders and 3 pumps. The rated horsepower will be 650, the lift of the water 171 ft.

PIPE SIZE NECESSARY TO SUPPLY DIRECT RADIATION

By Arthur McGonigal

FOR varying distances and different losses in pressure the diagram herewith is a convenient method of determining the commercial size of pipe necessary to supply direct radiation. On the upper margin of the diagram are figures representing the square feet of direct radiation to be supplied and on the bottom the commercial diameters of pipe. Horizontal lines marked "Trial Diameters," at the right margin, are intended for use where extreme refinement is called for. Losses in pressure in pounds per square inch, due to various causes, are represented by the long diagonals and the various transmission distances in feet by the short diagonals.

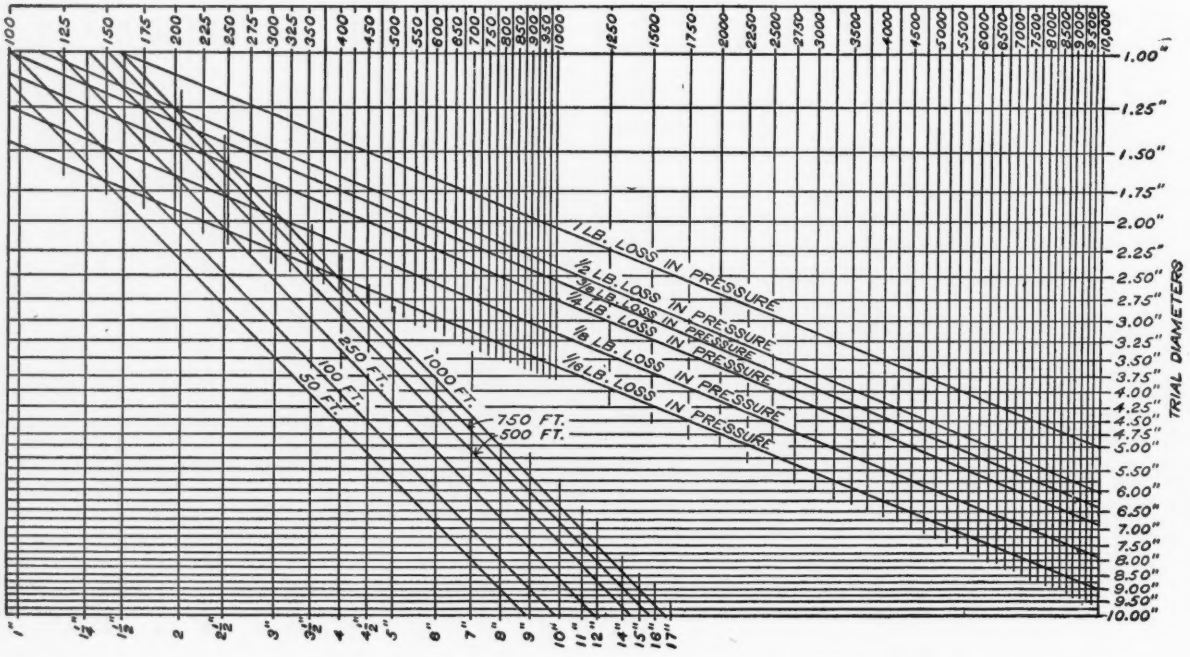


FIG. 1. DIAGRAM OF PIPE SIZES TO SUPPLY DIRECT RADIATION

Method of using the diagram is as follows:

Suppose that the amount of radiation to be supplied anl its distance from the boiler be known. The desired loss of pressure is assumed and determination of the pipe size is made as follows:

Assume direct radiation 2,200 sq. ft, distance 50 ft. and desired drop in pressure ⅜ lb. Find the intersection of the 2,200 vertical line with the diagonal representing ⅜ lb. loss, and trace across to the 50-ft. distance diagonal. From this point follow down to the bottom margin, giving the nearest pipe size as 3 in.

If the pipe is to contain a large number of fittings or other conditions make refinement necessary, equivalent resistance should be added to the actual distance of radiation from the source of supply. In the table herewith will be found the pipe lengths which will offer resistance equivalent to fittings of various sizes as indicated. In this case, the size of pipe to be used in determining the fittings resistance will be found from the trial diameters on the top of the diagram.

Taking the previous example, suppose that 3 elbows, 1 globe valve and 5 entrances are to be cared for. From the intersection of the 2,200 ft, and ⅜-lb. loss line, following to the right, we find the nearest trial diameter is 3.5 in. In the table a 3.5-in. elbow corresponds to 11 ft. 8 in., and 3 such elbows will correspond to 35 ft. of pipe. A 3.5-in. globe valve corresponds to 23 ft. 4 in. of pipe, and the 5 entrances will correspond to about 86 ft. The resistance offered by fittings and valve will, therefore, be equal to 35+24+86=145 ft. practically. This added to the actual length of pipe in 50 ft, gives revised distance of 195 ft.

FIG. 2. PIPE RESISTANCE EQUIVALENT OF FITTINGS. FEET TO BE ADDED FOR EACH FITTING

	1"	1¼"	1½"	2"	2½"	3"	3½"	4"	4½"	5"	6"	7"	8"	9"	10"
ELBOWS	3'-4"	4'-2"	5'-0"	6'-8"	8'-4"	10'-0"	11'-8"	13'-4"	15'-0"	16'-8"	20'-0"	23'-4"	26'-8"	30'-0"	33'-4"
GLOBE V.	6'-8"	8'-4"	10'-0"	13'-4"	16'-8"	20'-0"	23'-4"	26'-8"	30'-0"	33'-4"	40'-0"	46'-8"	53'-4"	60'-0"	66'-8"
ENTRANCE	5'-0"	6'-3"	7'-6"	10'-0"	12'-6"	15'-0"	17'-6"	20'-0"	22'-6"	25'-0"	30'-0"	35'-0"	40'-0"	45'-0"	50'-0"

Following across now from the intersection of the 2,200 sq. ft. and the ⅜-lb. loss lines to the short diagonal for 195 ft., and then down to the bottom gives

4-in. pipe as the nearest commercial size. Of course, by changing the order of the operations problems may be solved whether the unknown quantity be radiation, loss in pressure or distance.

For those of an inquisitive turn of mind as to the wherefore of this diagram, it may be stated that it is derived from the equation;

$$\text{Diameter in in.} = 0.27 \sqrt[5]{\frac{R^2 L}{H}}$$

where R is the radiation in square feet, L the length of the pipe in feet, and H the height of a column of steam whose weight would equal the drop in pressure. The diagram is computed on the basis that 1 sq. ft. of radiation will condense 0.3 lb. of steam per hour; for indirect radiation, which will condense 0.45 lb. of steam per hour, 50 per cent should be added to the amount of surface actually to be supplied, and for coils to be used in a blower system the amount of radiating surface actually to be supplied should be multiplied by 6 before starting to use the diagram.

DISMANTLING AND GENERAL REPAIRS TO A REFRIGERATING PLANT

By William S. Luckenbach

BEFORE commencing to dismantle an ice machine for general repairs, a number of things must be taken into consideration, especially when there is a certain demand for either ice or cold storage during the winter months, and only 1 machine is installed, so that expeditious and systematic work is absolutely essential.

Having determined as to the parts requiring renewal, and new adjuncts to be added, see that they are all on the ground before commencing, and should the plant be located where pipe, valves and fittings cannot be readily obtained, it is advisable to order some extra in order to avoid delay, even if they have to be returned at your expense.

Have the matter thoroughly gone over in your mind as to how you propose to dismantle and repair the various parts, and make notes of it so that, if necessary, the machine can be started up at a few days notice.

Shutting Down

Usually the generator, analyzer, rectifier and poor liquor exchanger are first taken in hand. As a preliminary to shutting down, fill the storage house to its full capacity; freeze the cans solid and circulate brine through the storage house, then stop the ammonia pump with the liquor low in the still and also low in the absorber.

In order to do this, it may be necessary to draw liquor out of the absorber into an empty drum, and when the pressure in the generator is say 70 lb. close the steam valve, also the gas valve to the condensing coils, also note the frost beyond the expansion valve and as soon as it gets moist close the expansion valve tight. The reason for leaving the expansion valve open as long as possible is to relieve the condensing coils of all the pressure possible.

Now break connections between the steam valve to the coils in the generator, attach a hose or pipe and run water through the coils to cool the liquor rapidly; be sure to break the outlet of the steam coils before admitting water through the coils, so as to prevent this water entering the distilled water tank.

If there is an air pump, attach a pipe or hose to one of the try cocks or other opening and force the liquor remaining in the generator and exchanger into the absorber; should there be no air pump, use the ammonia pump, (providing enough air pressure can be had) by disconnecting from the absorber, and force air through the rich liquor pipe, thus forcing all rich liquor in the exchanger coil into the still, and from there through the poor liquor pipe into the absorber, or if there is an opening at the bottom of the generator, force direct into a drum. By this method there will not be 25 lb. of aqua ammonia lost in a 30-ton machine.

STRENGTH OF AMMONIA LIQUORS

PERCENTAGE OF AMMONIA BY WEIGHT	SPECIFIC GRAVITY	DEGREES BEAUME WATER, 10°	DEGREES BEAUME WATER, 0
0	1.000	10.0	0.0
1	0.993	11.0	1.0
2	0.986	12.0	2.0
4	0.979	13.0	3.0
6	0.972	14.0	4.0
8	0.966	15.0	5.0
10	0.960	16.0	6.0
12	0.953	17.0	7.0
14	0.945	18.3	8.2
16	0.938	19.5	9.2
18	0.931	20.7	10.3
20	0.925	21.7	11.2
22	0.919	22.8	12.3
24	0.913	23.9	13.2
26	0.907	24.8	14.3
28	0.902	25.7	15.2
28½	0.900	26.0	15.5
30	0.897	26.6	16.2
32	0.892	27.5	17.3
34	0.888	28.4	18.2
36	0.884	29.3	19.1
38	0.880	30.2	20.0

In the meantime all the rigging should be in place to dismantle all the above mentioned parts.

Distillation

Frequently towards the end of the season the aqua ammonia gets below the standard say 24 deg. Beaume instead of 26, and as the weather is getting cooler it is preferable to continue that way rather than supply either additional anhydrous or aqua ammonia.

When, however, the time it at hand to shut down, it is desirable to enrich the entire charge to 26 deg. or 28 per cent of pure ammonia, and the problem for the engineer to solve is how much weak ammonia water must be withdrawn by distillation in order to bring

the entire charge to standard. The approximately correct quantity can be figured out as follows:

Suppose that the quantity of aqua ammonia at 24 deg. in the generator exchanger, rectifier and absorber amounts to 10,000 lb. and by reference to the percentage table, we find that when Beaume scales indicate 24 deg., 24 per cent of that is pure ammonia and 76 percent distilled water. We also note on the table that pure water indicates 10 deg. but as it is not practicable to distill that low, we will assume the water has 2 per cent of ammonia which, as per table is 12 deg. Beaume. Deducting this 2 per cent leaves 22 per cent of ammonia and 78 per cent of ammonia water, and as 26 deg. contains 28.5 per cent of ammonia, there is a deficiency of 6.5 per cent to be supplied; hence, in order to know how much ammonia water at 12 deg. to draw out of the generator to bring the balance to 26, we have the following example: $10,000 \times 0.78 \times 0.065 = 507$ lb.

The writer's method of distilling is as follows: Fill the generator as full as practical; then stop the ammonia pump, close the poor liquor valve at the generator and carry a good steam pressure, because the lower the percentage of ammonia in the water, the more heat will be required to liberate the gas. When the pressure in the still is say 35 lb. assuming that the condensing coils are not more than 20 ft. above the generator, draw some and test it. If 12 deg. has been reached, close the steam valve, also the gas valve on top of the generator and the expansion valve and draw off the required amount.

By this method you have only the liquor in the generator to distill which should not take more than 2 or three hours; otherwise, by leaving the poor liquor valve open, all the liquor in the cooling coils must be distilled, thus not only causing delay but distilling more than is required. This is especially important when distillation must be done during the busy season, when every hour is valuable.

Generator and Exchanger Coils and Pipes.

The generator and exchanger coils and pipe frequently have a scale formation on the exterior due to impurities in aqua ammonia, this is very detrimental to the generation or liberation of gas because of its nonconductivity and must be hammered or picked off and the coils tested to 500 lb. pressure.

Should any leak develop when testing, there is only one sure way to avoid trouble during the season, and that is a new coil or pipe as the case may be. The writer has, however seen coils soldered that lasted 2 seasons and were then renewed only as a precautionary measure, the metal must be thoroughly clean and bright and the soldering done by a competent man.

Pipe and Fittings

Valves of every kind, but especially ammonia valves should be put in first class order or replaced by new ones. Have valves close to the condensing and cooling coils and have them so located that they can be easily reached in case of accident in the machine room, thus saving the charge; or in case repairs are to be made during the season by holding the liquor in the respective coils. Have all flanges whether on valves or otherwise scored to lessen the chance of a blowout. Use first-class sheet rubber on all ammonia joints.

Ammonia fittings should be the best that can be obtained; long bend elbows are preferable as they lessen friction. The fittings should be heavy and have good sharp threads; nipples should not be used a second time on ammonia; they should be extra heavy with clean threads and no internal ragged edges from the pipe cutter, which not only leave projections for any foreign substance to adhere to, but decrease the area of the pipe as well.

Do not use red or white lead, litharge, or any other thick substance to make the joints, because there are granules in these pastes that will jam between the threads. This is very deceptive in screwing up a joint, so that while it is apparently tight because it screwed up hard, it is not permanently so, and ammonia will soon cut its way through, until you have a leak that may be difficult and expensive to fix at that particular time. Hence, in making ammonia screw joints, use flake graphite and good lubricating oil or a similar preparation. Then screw up good and hard, metal to metal, and you not only have a lasting job but one that can, if necessary be again unscrewed.

Bolts and Studs

Run the dies over all old bolts and studs and have the threads long enough to prevent the nut from jamming into the body of the bolt or stud. This is very important as a leak may be where it is difficult to work when the pipe is once filed with ammonia. The writer knows instances where some loss and considerable delay were caused by a flange joint leaking, though apparently screwed up hard, and it was finally found to be due to the nut jamming into the body of the bolt.

Having attended to these apparently small details and supplied new analyser and rectifying pans where necessary, re-erecting is in order, which needs no special mention.

Absorber

Should the absorber coils or pipes need renewing or repairing, draw the remaining liquor, after the generator is filled, into drums and treat the coils in the same manner as the generator coils. Be sure that the poor liquor spray pipe is clean,—this is important,—and make provision for blowing it out should the spray get clogged. Also make provision to run the poor liquor to the absorber, temporarily through a bypass should it become necessary to remove the spray pipe by reason of being clogged.

Attach an automatic ammonia regulator to the absorber; this is a great labor saving device as it absolutely regulates the flow of poor liquor regardless of the pressure so that with it and a good ammonia pump

governor, the engineer can leave the machine room with safety to look after other matters about the plant, and devise methods of economy that will repay the price of installation in a short time.

Ammonia Pump

It is needless to go farther into details relative to this important piece of machinery than to say that it must be in first-class condition in every part, whether run by steam, belt or motor gearing. The space between the plunger and the valves should be reduced as much as possible to prevent the pump getting air or gas bound. This can usually be done by securely fastening pieces of metal to the cylinder heads in such a manner as not to obstruct the passage of the liquor to and from the discharge and suction valves; by that means the pump can be run at the lowest speed and supply the proper amount of rich liquor to the generator, which amount should not be less than about 7 cu. ft. per hour per ton of ice in 24 hr. provided that the distillation is 14 per cent. To verify this, the writer at various times at July temperature tested it on a 30-ton machine, average generator pressure 185 lb., steam pressure 90 lb., absorber 6 deg., cooling water 82 deg., distilled water in cans 52 deg., brine 12 to 14, feed water 195 deg., and liquid ammonia 97 per cent pure. The capacity of the pump after deducting 8 per cent for defects in plunger and valves was 246 cu. feet an hour.

Aqua ammonia at 26 deg. Beaume scale contains 28.5 per cent of anhydrous, and as the capacity of the pump is 246 cu. ft. delivered into the generator and there distilled from 26 deg. to 18 deg., or 14 per cent, and as 1 cu. ft. liquid ammonia at 185 lb. pressure weighs 36 lb., we have the following example:

$246 \times 0.14 \times 36 = 1239.84$ lb. of liquid ammonia. The latent heat of evaporation expressed in thermal units at 6 lb. absorber pressure being 565, we have $1239.84 \times 565 = 700{,}507.60$ B. t. u.

The standard for 1 ton of refrigeration being 284,000 B. t. u., and the generally accepted amount of heat to be extracted to produce 1 ton of ice being one and one-half times that amount, or 426,000 B. t. u., the example will be $426{,}000 \div 700{,}507.6 = 1.64$ ton an hour, or $1.64 \times 24 = 38.36$ tons a day of 24 hr. From this should be deducted, however, about 10 per cent due to radiation in tank, exposure and meltage in removing ice, so that $38.36 \times 0.9 = 34.52$ net tons of ice that the pump is capable of supplying, which is about the proper size, because in cold weather the machine will easily make from 12 to 15 per cent over its rated capacity.

Air Pump

In reference to the air pump, it is only necessary to say that it must be put in first-class trim for the season, and, if only used for lifting the ice cans it will be well to consider the economy of running the pump only while pulling ice, because the hourly pulling very seldom exceeds 45 min., hence, there would be a saving of at least 20 per cent in power.

It is not necessary to install an expensive air compressor. The writer made one by using an old 7 by 8-in. engine with another cylinder of the same dimensions taken from the junk pile. This was rebored, and both heads drilled for 1-in. checks to be used for suction and discharge, allowing as little clearance as possible for the plunger, which had the ordinary 3-ring packing sprung in the cylinder. Good provision was made for lubrication, but no water jacket, as the cylinder kept fairly cool under 60 lb. pressure owing to the fact of being operated only while pulling ice. The appliance was ample for a 60-ton machine, and gave no trouble whatever during the season. We had, however, hand methods of pulling in case any unforeseen accident should occur.

Condensing Coils

The condensing coils, whether atmospheric or double-tube type, require only a good cleaning, if no leaks have developed. If they are exposed to the sun's rays, they should be protected in order to decrease the water supply or lower the temperature with the same quantity of water; be sure to have the valves, heretofore mentioned, inserted.

Freezing Tank and Expansion Coils

This work requires expeditious management for 2 reasons; first, the coils should not be exposed to the atmosphere longer than is required to do the work on account of rusting; second, because there is no freezing tank full of ice to fall back on in case of extra demand for ice, as in the case of repairs in the machine room. If the freezing tank is wood with no leaks, which can be determined by examining the insulation at various points, there is nothing special to do but clean the bottom of the tank, which is only necessary say every third season; this applies to the coils also.

If, however, the tank is steel, it will require frequent and thorough painting to prevent rusting. To do this effectually without disturbing the coils, lower the brine as much as possible without exposing any part of the coils to the atmosphere; then clean and repaint, and do not leave even 1 sq. in. unpainted; the other part being immersed, the same as the coils, will not require it so often.

Before disconnecting the coils, see that no liquor remains in them. If the bath is above the liquor level in the absorber, liquor will flow to it by gravity, but when the bath is on a level with the machine room the liquor must be drawn out of the coils by producing a partial vacuum in the absorber before the machine is shut down.

Disconnect the coils and blow out each coil separately with steam pressure and test them with brine to 300 lb.; then follow with air pressure to rid the coils of the liquor. The reason for using brine to test instead of water is to avoid the possibility of water remaining in them and freezing, thereby decreasing the area of the pipe or possibly bursting it. It is very important that any kinks or bends that would be liable to form a trap should be straightened.

It is convenient to have valves on each coil, and the additional expense may be warranted should 1 or more coils get clogged or leak during the season so that it cannot be remedied at that time, thus losing the partial, or entire, value of that amount of refrigerant. Anyway, they should be divided into sections of 2 or more, according to the size of the bath, instead of 1 continuous manifold, because first, all liquids, gases, steam, etc., under pressure will, upon opening the valve take a more or less straight course unless diverted. In this case it would go to the far end, hence, the farthest point from the expansion valve would be the coldest. But, if divided into sections, or separate coils, the gas can be easily regulated.

In reconnecting the coils, be sure that the flange connections are perfectly clean, and use the best rubber obtainable for this purpose, because these joints are usually inaccessible, especially after being filled with gas, hence the material and workmanship should be of the best, and no pipes or nipples should be used unless they are known to be internally clean and free from blisters.

Thermometers

The installation of thermometers at the various places mentioned later on will be found by the engineer to be invaluable, and quickly repay the owner for the outlay, as the decreased temperature of the feed water, increased temperature of the poor liquor in the absorber, or the liquid ammonia near the expansion valve will be seen at a glance and the remedy applied at once. For instance, if the liquid ammonia temperature increases only 3 or 5 deg., which cannot be detected by simply grasping the pipe, the expanded gas in the bath coils will absorb from 5 to 8 times less heat, hence, when he sees the increased temperature he does not have to wait until he finds the bath has gone up several points, and even then not know positively what caused it; but will at once know the cause and apply the remedy, viz.: more cooling on the condensing coils, thus preventing increased temperature of the brine and a possible reduction in capacity.

The points where these thermometers or mercury wells should be placed are as follows: Feed water near the boiler, cooling water near the condensing coils, liquid ammonia near the expansion valve, manifold connected to the bath coils, poor liquor pipe near the absorber, and one direct connected to the absorber.

By making notes at which temperatures the machine does the work best, the engineer will have the whole matter under control, and in case of any deviation he will know with absolute certainty the cause and remedy.

Having thus completed the principal parts, we are ready to charge the machine and start up.

"ACCORDING AS WE ACCEPT or ignore our responsibility as trustees of the nation's welfare, our children and our children's children for uncounted generations will call us blessed or will lay their suffering at our doors."

TAKING CHARGE OF A REFRIGERATING PLANT

BY BISMARK KING

SOME months ago, the writer took charge of the mechanical end of a factory, having as part of its equipment a 65-ton refrigerating plant, used for cooling storage rooms and water; the refrigerating rooms being cooled by chloride of calcium brine, and the water by direct expansion ammonia coils. The plant is electrically driven, and was in a somewhat run down condition when the factory changed hands.

The Compressor and Pump

The double acting ammonia compressor is driven by a 137-hp., 220-volt direct-current, compound-wound motor, running 65 r. p. m. and directly connected to the crank shaft of the compressor. The brine pump is a double acting triplex power pump, having cylinders 5.5 in. in diameter and an 8-in. stroke, and is belted to a 10-hp., 220-volt motor.

This pump was in pretty bad shape, and caused more annoyance than anything else in the plant. The rods were worn until they had a bad shoulder, and instead of replacing them or having them turned down, they had kept screwing down on the stud bolts to keep the stuffingbox from leaking. This treatment being persisted in broke the studs, and as no one was in the plant when it happened but the watchman, the larger part of a tank of brine was lost before the pump was shut off.

Then the stud-bolts were discarded, and clamps bolted to the heads, fitting over the glands. Wooden blocks were also inserted between the glands and the frame to catch the gland when the clamp broke, which I am told was quite frequently. Just to show his idea of a joke the outgoing engineer slipped the blocks out and, if the fireman hadn't noticed his doing it, I should have lost some brine also, as some of the clamps let go before I got the new piston rods in.

That Pesky Pump

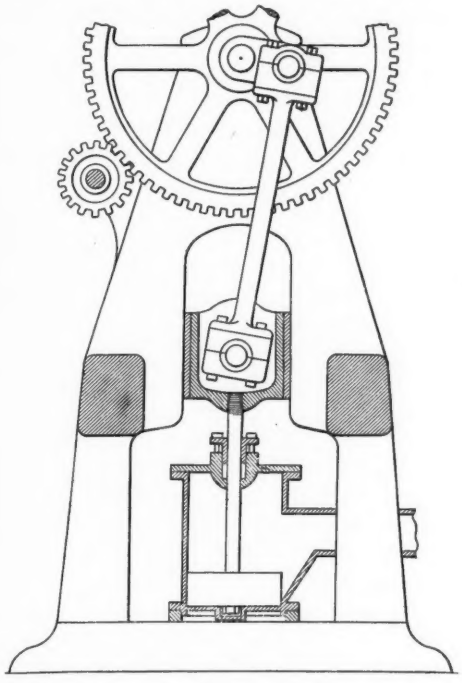
As before stated, the pump is belted to a motor, the speed being reduced by gears, and the larger gear sets directly over the center crosshead. After replacing the rods, cylinder heads, and stuffingbox glands, the pump worked nicely; but getting the head and rod into the middle cylinder was a picnic.

The gear sets so close to the crosshead guides that the crosshead cannot be taken out without moving the gear, which makes it necessary to hoist the crank shaft. If the cylinder was fastened to the frame with a plain joint, it could be taken out horizontally; but the joint is grooved so that, unless you back out the studs that fasten the valve chambers to the side of the cylinder, you cannot move the cylinder. Any one who has backed studs out of a rusty brine pump will tell you that the chance of getting them out without breaking them off is slim.

So I hoisted the crank-shaft up enough to get the crosshead out and thought my troubles were over.

By pushing the rod all the way into the cylinder. I expected to be able to get the head out but the distance between the top end of the rod and the frame was too short to allow the head to pass under the frame horizontally, and the opening in the frame too small to allow the head to be taken up vertically.

Then I tried to get at the nut on the plunger end of the rod by pulling the rod as high as the frame would allow. When I got it up I could see the nut all right, but the space between the top of the cylinder and the bottom of the plunger was so narrow that I couldn't get any wrench I had, in. After getting a very thin wrench made, and bending it a little, I succeeded in getting the nut off the rod. The rest was easy. The same gentle operation was repeated in replacing the parts.



ARRANGEMENT OF THE BRINE PUMP CYLINDER

A Lame Motor

The main trouble, however, was with the large motor on the ammonia compressor. The plant had been run for about 2 years before anybody noticed the fact that the oil from the outboard bearing, was running along the shaft and into the commutator. About that time the insulation began to break down, and segments began to short circuit. It speaks well for the motor that the oil took effect no sooner.

The motor was running all right when I started at the plant, but after a few days' heavy load the oil-soaked insulation had reached its limit, and the commutator short circuited between 2 of the segments. The first notice I had of it, was when those segments began to get hotter than those adjoining, and raised up, due to the difference in expansion. By the time I got the switch pulled out, several brushes were broken, and the solder had melted between the armature coil and the commutator segment.

Of course knowing about the oil-soaked state of the commutator, I had no trouble finding the fault, and as it was impossible to shut the plant down long enough to re-insulate the commutator, I cut the coil out by severing the ear connecting the coil to the segment. I then soldered the ear to one adjacent to avoid an open circuit when the segment passed under a brush. After filing down the 2 high segments, the machine was started again and ran all right.

Since that time 4 more coils have been cut out, and I am hoping that the hot weather will be over before I have reached the limit of the number of coils that can safely be cut out. I estimate that 10 or 12 coils will be about all that the armature will stand.

An ammonia compressor, when directly connected, makes a very bad load for a motor on account of the compression load coming on the same segments twice in each revolution, while some of the others carry practically nothing. This in itself is enough to make trouble, unless the designer was liberal with copper—even with a heavy flywheel.

As soon as cold weather comes we can have the commutator reinsulated, and cure the trouble permanently. In the meantime I am playing nurse to a cripple, and thinking hard thoughts of the fellow who left me the legacy.

To make sure that I would not be tarred with the same stick, I have had pressure grease cups put on the bearing and of course no more oil will get into the commutator.

BOILER ACCIDENT

Engineers, firemen and others who have occasion to work inside boilers will be interested in an account of an accident in a California power plant. A boiler had been washed out and a gallon or more of distillate put in to cover the sheets. The front lower manhole plate was then put in and the boiler filled with water, the distillate put in the inside and floating on top of the water close to the top row of flues. As this boiler was No. 7 in a battery, the walls and tubes were warm enough to create a gas from the distillate which filled the boiler.

As it was necessary to connect the feed-water pipe inside the boiler, the steam fitter went into the manhole and, as the light was not very good, he called for a candle from the boiler washer. When the candle was passed to him, an explosion occured, setting fire to the workman's clothes and burning him about the face.

The fire was put out with a hose and the steam fitter taken out of the boiler in badly burned condition and died the following morning. Such accidents emphasize the need of the utmost care in handling fuels that are liable to produce explosive gases within a closed vessel.

T. L. A.

GETTING READY FOR THE EXAMINER

A SET OF EXAMINATION QUESTIONS, GIVEN FOR ENGINEER'S LICENSE IN MASSACHUSETTS

By A. C. Waldron

IF THE dashpot rods on a Corliss engine are lengthened, how does it affect the cutoff?

A. It will not affect the cutoff but the rods are liable to be so long that the rod or some part of the valve gear will break.

2. How can a 15-ft. length of 1¼ in. feed pipe be put inside an 18-ft. boiler in one piece?

A. In modern boilers the hole in the front head for the feed pipe is drilled and tapped for a bushing a size larger than the feed pipe, so that the feed pipe can be slid in first and the bushing put in afterward.

3. If you were looking over an old style Brown engine or a Putnam, without eccentrics, how could you tell the direction in which it would run?

A. Both engine cam shafts are driven by a pair of miter gears under the crank shaft. On the Brown

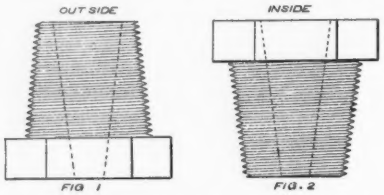


FIG. 1. OUTSIDE FUSIBLE PLUG
FIG. 2. INSIDE FUSIBLE PLUG

engine if the miter gear on the cam shaft is on the side nearest the valve gear, the engine will run under, making the strain come on the top guides. By changing the miter gear and placing it on the outside or the end of the cam shaft, the engine will run over.

For the Putnam engine these conditions are exactly the opposite. The top of the cam shaft in both cases turns away from the cylinder at all times.

4. What is the difference between an inside and outside fusible plug?

A. In all types of fusible plugs the metal is put in cone-shaped because the pressure acting on the larger base tends to force the metal to its seat and thus reduces the tendency for the metal to separate from the body of the plug. In an outside plug the hexagonal head sticks outside the boiler while the shank enters the boiler. In this case the larger diameter of the fusible metal is in the shank end. In the inside plug the conditions are reversed. Figures 1 and 2 show the two types of plugs.

5. What will cause the vacuum to be lost on the condensing engine?

A. It may be lost from a leak in the condenser or a leaky stuffing box on the low-pressure cylinder, a leak in the air pump, piston or valves, or the air pump valves may be out of place. There may be insufficient circulating water or the water too warm.

In a jet condenser there may be too much or too little water or the water may get warm or the spray nozzle may be clogged up.

6. If the valve stem on a Corliss engine should break, how could you prevent a shutdown?

A. Turn the valve with the broken stem so that it will cover the port and use some means to hold it there. Disconnect the exhaust valve on that end from the wristplate and block the valve so that it will always stay open. The engine will then run single-acting, developing about half its rated power, but, of course, with somewhat variable speed.

7. Suppose that in designing a slide valve engine with steam ports 1.5 in. wide and ¾ in. lap on the valve, the valve is to be driven by an eccentric, how far from the center of the eccentric shall the hole be bored for the crank shaft to give the proper throw?

A. The travel of a slide valve is twice the lap

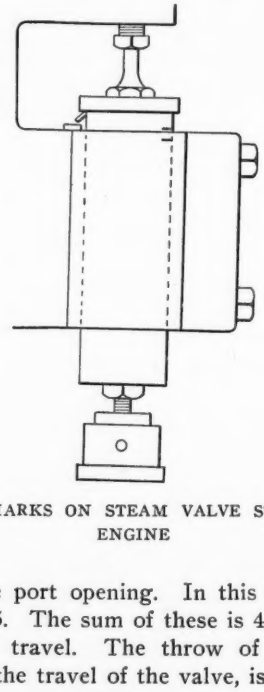


FIG. 3. LAP MARKS ON STEAM VALVE STEM OF BROWN ENGINE

plus twice the port opening. In this case $2\times1.5=3$ and $2\times\frac{3}{4}=1.5$. The sum of these is 4.5 in., which is the necessary travel. The throw of the eccentric, which equals the travel of the valve, is twice the distance from the center of the eccentric to the center of the crank shaft, so that if the hole is bored 2.25 in. from the center of the eccentric it will give the required 4.5-in. travel.

8. How can you tell for a Brown engine that is running how much lap has been given the steam valve?

A. On the valve stem are 2 scratch marks, the distance between these being the amount of lap. When the valve is down the lower one goes out of sight,

while the upper one should be even with the guide. When the lower mark shows above the guide the valve is just open or getting its lead, as shown in Fig. 3.

9. If you had a feed pump with a 4-in. water end and wanted one of twice the capacity, what size would you order?

A. The area of a 4-in. plunger is 12.56 sq. in. and the area of a 5⅝-in. plunger is 24.85 sq. in., which would be about twice the capacity.

10. What effect will cutting off later in the high-pressure cylinder have on the receiver pressure of a compound engine?

A. The receiver pressure will be raised, the engine doing more work, and the low-pressure cylinder doing more work in proportion than the high-pressure because the initial pressure of the low-pressure cylinder is raised while at the same time the back pressure on the high-pressure cylinder is increased.

11. How would you equalize the cutoff on a Brown engine?

A. The cutoff mechanism on the crank end is held by set screws only, while that on the head end is held by set screws and a taper pin. To adjust, set the crank end for the latest cutoff and then equalize on the head end by pulling out the taper pin for late cutoff and pushing it in for early cutoff. By careful adjustment in this way a very even cutoff can be secured.

12. If the area of the low-pressure cylinder was 1256.64 sq. in. and the high-pressure cutting off at 0.2 stroke is ¼ as large in area, what would the diameters be; also, how many expansions would there be in the high and low-pressure cylinders combined?

A. If the area of the low-pressure cylinder is 1256.64 sq. in., the diameter is 40 in. and if the high-pressure has ¼ the area, it will have ½ that diameter, or 20 in. If cutoff is 0.2 stroke in the high-pressure cylinder there will be 5 expansions in that cylinder, and since the volumes of the cylinders are as 4 to 1, there will be 4×5=20 expansions for the entire engine.

ANSWERS TO HOISTING ENGINEERS' EXAMINATION QUESTIONS

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1. Honesty and sobriety.

2. Not acquainted with the law of Illinois.

3. Ascertain the water level in the boilers; note the steam pressure; the condition of the gage cocks and gage glass; the condition of feed pumps, and the condition of oil cups and lubricators, and examine the cable.

4. When in use from 1.5 to 2 gages of water. Preparatory to shutting down for several days, fill boiler to third gage, blow down to 1 gage; draw the fire and let the boiler cool down. Open the safety valve, or any other accessible point on top of the boiler, fill the boiler with cold water, add a small quantity of salsoda and close up the boiler.

5. Close all air communication with the under side of grates; cover the fire with a thick layer of ash or green coal; leave the damper and fire doors partly open. Don't feed any fresh water nor tamper with any steam outlet. When sufficiently cool, draw the fire and examine the boiler. If uninjured proceed same as when getting up steam with new fire.

6. Bank the fire and shut off the draft.

7. Find the thickness of the fire, that with the draft and character of fuel on hand, gives the greatest intensity of heat in the furnace. Maintain this condition by firing small quantities evenly and at regular intervals. Look out for holes and short circuits of cold air to the stack. Keep the fire clean, free from ash and clinker. Do not clean the fires oftener than necessary. Do not let steam blow off.

8. Do not allow the valve to be overloaded. Lift valve cautiously once in 6 hr.

9. Because he must rely on the gage cocks to located the water level in case of accident to the water glass.

10. Water carrying sewage and organic matter or oil in suspension. Filter the water.

12. $$\frac{11\times6^2\times100\times7.5}{14\times144}=147.3 \text{ gal.}$$

13. The ohm is the unit of resistance to the flow of an electric current.

The volt is the unit of potential or pressure.

The ampere is the unit of the rate of flow of an electric current.

14. Volts×amperes=watts.

$$\frac{\text{watts}}{746}=\text{hp.}$$

$$\text{hp.}=\frac{100\times250}{746}=33.5$$

15. Heating surface in the tubes equals 70×18×0.2618×4=1319.4 sq. ft. Heating surface in shell 0.2618×72×18×2/3=226.2 sq. ft. Heating surface in heads

$$\text{Gross front head}=\frac{11\times6^2}{14.}=28.3 \text{ sq. ft.}$$

$$\text{Back head}=\frac{2\times28.3}{3}+3\times1\tfrac{1}{2}=23.4 \text{ sq. ft.}$$

$$\text{Area of tubes}=\frac{11\times70}{14\times9}=6.1 \text{ sq. ft}$$

Summary of heating surface:

Tubes, sq. ft.	1319.4
Shell, sq. ft.	226.2
Front head, sq. ft.	28.3
Back head, sq. ft.	23.4
	1597.3
Subtract tube ends	12.2
Net heating surface, sq. ft.	1585.1

Addison Goodfellow.

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1. He should be sober, reliable, able to think quickly and do the right thing at the right time, cool headed in an emergency and at all times attend to business.

2. Not familiar with these laws.

3. While to those acquainted with the local conditions there may be something peculiar to such I think that assuring himself that every thing was in proper condition both engine and boiler, would cover the ground.

4. When running, about 2 gages or half a glass; at other times preferably a little higher unless shut down for a long period when boiler should be emptied and dried and if possible to do so, pans of fresh lime placed inside to absorb dampness, and closed up.

5. Stop draft, cover fire with wet ash or coal, if no ash is available; after the fire has cooled off, and it is positively known that water has been out of sight but a short time, water may be slowly fed, but if at all uncertain, pull fires before feeding any water and then very slowly.

6. The engineer should be governed by circumstances. If previously notified that water would be shut off and it was very necessary that engine be kept running as long as possible, he should fill boilers as full as would be safe for the engine and run down to about 2 in. of water in the glass; then bank fires and after steam had dropped enough to avoid safety valve blowing, stop engine.

If water was stopped without previous notice, engine should be stopped as soon as fires could be banked and steam lowered. Local conditions might make necessary a different procedure but at all times the engineer should try to be on the safe side.

7. According to fuel used the method would have to differ but the aim should be to have a clean, regular and lively fire, keeping fire doors closed as much as possible, firing evenly and in moderate quantities, not allowing any holes to form. With most fuels I consider the alternate method the best as the furnace is not cooled so much and there is always a hot fire on 1 side to burn the gas from the green coal just fired on the other.

8. The safety valve should always be ready for business and the best way to keep it so is to raise the pressure at least once a day, high enough to operate the valve. Where circumstances make this plan impracticable, the valve should be raised by hand carefully every day.

9. It is usually as easy to try one as the other, neither should be neglected; the glass is very easily kept clear by occasionally opening drain valve and the water can be seen slowly rising and falling when the boiler is working. But the cocks become very necessary, if the glass should break, so the only way to know if the cocks are in working order is to try them when trying the glass.

12. As the size of the piston rod is not given I will have to assume that it does not occupy any space.

A 6-in. piston has an area of 28.2744 sq. in.

$$\frac{28.2744 \times 12 \times 100}{231} = 146.88 \text{ gal. per. min.}$$

13. A volt is the pressure or e. m. f. required to send 1 ampere through a resistance of 1 ohm.

An ampere is the amount of current flowing through a circuit having a resistance of 1 ohm, with an e. m. f. of 1 volt.

An ohm is the quantity of resistance which requires an e. m. f. of 1 volt to cause 1 ampere to flow through a circuit.

14. $\frac{100 \times 250}{746} = 33.51 + \text{hp.}$

15.

Area tubes	1318.8	sq. ft.
Area shell	223.93	"
Area heads	37.32	"
Total	1580.05	"

Considering two-thirds of shell and heads as effective heating surface. Harry H. Yates.

Some of the questions are only partially answered or incorrectly in the sets given above and answers to these prepared by Mr. Stewart who contributed the questions are given below.

1. Persons seeking certificates of competency as hoisting engineers must produce evidence satisfactory to the board that they are citizens of the United States, at least 21 years of age, that they have had at least 2 years experience as fireman or engineer of a hoisting plant, and are of good repute and temperate habits. They must be prepared to submit to and satisfactorily pass an examination as to their experience in handling hoisting machinery, and as to their practical and technical knowledge of the construction, cleaning and care of steam boilers, the care and adjustment of hoisting engines, the management and efficiency of pumps, ropes and winding apparatus, and their knowledge of the laws of this state in relation to signals and the hoisting and lowering of men at mines.

2. The hoisting engineer at any mine shall be in constant attendance at his engine or boilers at all times when there are workmen underground. The engineer shall not permit anyone to enter or loiter in the engine room except those authorized by their position or duties to do so, and he shall hold no con-

versation with any officer of the company or other person while the engine is in motion or his attention is occupied with the signals. He must thoroughly understand the established code of signals, and when he has the signal that men are on the cage he must work his engine only at the rate of speed specified by law, (which is 400 ft. per minute). Engineer shall permit no one to handle or meddle with any machinery under his charge, nor suffer any one who is not a certificated engineer to operate his engine, except for the purpose of learning to operate it and then only in the presence of the engineer in charge, and when men are not on the cage.

3. To know that all machinery is ready and safe for the shift, to know which boilers are off and that his fireman is on hand and to know his pumps are O. K.; know how much water he has in boilers and when the fan was oiled and its condition.

4. To notify the mine boss so he could get the men out of mine before you shut down the fan and if water don't come right away and its getting low in boilers shut down fan and other machinery until it does, and with everything shut off you can hold the boilers as they are for quite a while and then when water is restored can start fan and other machinery.

11. $\frac{60\times24^2\times0.7854\times2\times3}{8\times3.1416}$ = 6480 lb.

PATCHING BOILERS AND CYLINDERS

THIS is a class of work, in which each case has different conditions from the experience of the repair man on other jobs, and therefore requires good judgment and practical knowledge.

When a boiler plate shows signs of a blister, while in itself not dangerous in all cases, it should be patched to be on the safe side. Likewise, when a bag appears, it should be patched or a new sheet put in at once, as a bag is always an element of danger and constant trouble.

Two kinds of patches are generally used on boiler plates, hard and soft.

Usually soft patches are used for repairs of a temporary nature, when time to do a permanent job is lacking, or when it would be necessary to dismantle a portion of the boiler.

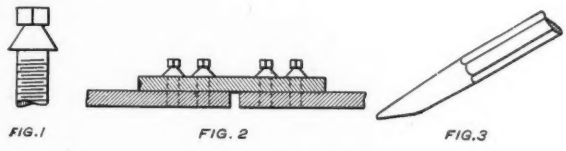


FIG. 1. PATCH BOLT
FIG. 2. SOFT PATCH
FIG. 3. CALKING TOOL

Soft Patching

In a soft patch a piece of boiler plate of sufficient size to cover the crack, or blister is obtained, and rolled to the curvature of the boiler shell. Holes are then drilled and tapped a sufficient distance on each side of the defect to secure a good hold in sound metal for the patch bolts.

These patch bolts have head shown in Fig 1, which enables them to be screwed home and the square or hexagon head cut off, leaving the appearance of a rivet. The other end of the bolt should always be riveted over when possible to do so. The holes laid out in the boiler plate are transferred to the patch and drilled.

A filling composed of red lead and iron filings, or small borings, is then mixed to a stiff paste and applied evenly between the boiler plate and patch. The "patch" is worked to and fro to bed the paste and secure a good distribution and good suction. Then the patch bolts are screwed home, the heads cut off, and the edges of the plate calked.

For calking, a round nosed tool as shown in Fig. 3 should be used, as this is not liable to damage the plate by cutting into it.

Hard Patches

In this class of work the defective metal is always cut out and a piece of boiler plate rolled to the curvature of the shell as before. The holes for the rivets are drilled in both the boiler and patch. The patch is then placed inside so that it overlaps as shown in Fig. 4, and rivets are used to secure the patch in place, and afterward the plates are calked.

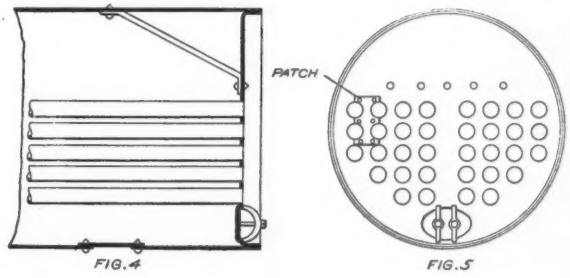


FIG. 4. HARD PATCH
FIG. 5. PATCHING A BOILER HEAD

This is the proper way to make repairs and should always be done when possible as it makes a reliable job.

By putting the patch inside the boiler no pocket for sediment to lodge is presented as would be if placed, as in the case of a soft patch, on the outside. Also the steam pressure acting on the area of the patch assists in maintaining a tight joint. Should

the patch be placed on the outside the tendency for the pressure would be to blow it off the boiler, and the chances are it would continually give trouble by leakage.

It sometimes happens that the head will crack from tube to tube. To repair this a piece of metal is cut to encircle one or more tubes and of sufficient width to be placed between the tubes, leaving a good bearing on the head, covering the crack. It is then riveted on or secured by patch bolts, making a soft patch as in Fig. 5. Smooth-On and the other iron cements are good in making repairs of a like nature.

Patching Cylinders

Sometimes an engine will receive a dose of water, and the cylinder head, or the flange on the cylinder, steam or exhaust chest, or perhaps the valve bonnets will crack.

Then it is usually necessary for the engineer to make repairs. Generally speaking, a piece of suitable metal is cut to the desired size, and if the crack is located on a curved surface, it is best to conform to that curvature.

Holes for the reception of suitable cap screws are laid out, drilled and tapped. These holes are again transferred to the patch. Before securing the patch in place, the surfaces should be thoroughly cleaned of all oil and grease. A strong caustic soda solution or ammonia, will clean things in good shape.

A rust joint can sometimes be used to good advantage, and is made as follows:

A mixture of sal ammoniac and iron filings in equal parts are mixed with water to form a stiff paste, then applied to the crack. The patch is applied, and an even pressure exerted over the entire surface to bed the metal into the paste. Then the cap screws are drawn up tight.

Again, good results can be sometimes secured by a paste composed of red lead and litharge in equal parts.

LARGE TRANSFORMERS

A recent number of the General Electric Review gives some information in regard to the size of transformers now being made for long distance transmission. Until recently the highest voltage regularly used was 60,000 to 70,000 volts, but now they have made shipments within a few months of several transformers having 100,000 volts on the high-tension side. These have oil insulation, are water cooled and run from 400 kw. up to the largest 10,000 kw. which have been made for the Great Western Power Co.'s Feather River installation. The largest are so big that they have to be disassembled for shipment, and each unit occupies floor space 9.5 by 18 ft., stands 18 ft. high and weighs 120,000 lb.; it requires 7,500 gal. of oil to fill a single transformer tank. Although the losses are only 1 per cent, that represents 125 hp.

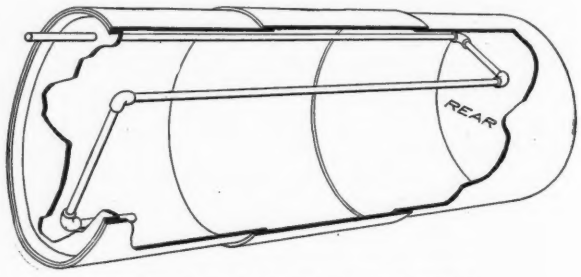
BOILER FEEDING

By William Westerfield

IN KEEPING a boiler clean the best circulation that it is possible to secure, is, I believe, desirable. Not only for this reason, but also in order that the water may receive the greatest amount of heat from the furnace, good circulation is desirable. Hence for two very important reasons, the subject of feeding boilers is one of the greatest importance.

It must appear that in order to get the best circulation, it is essential that we introduce the feed water at the point where the least evaporation takes place, and this will be the part of the boiler that is the least exposed to the heat of the gases as a whole. I have met engineers and others who advised that the feed water should be introduced at the rear, or blowoff end of the fire tube boiler of the return tubular type, because that is the coolest part of the boiler.

We know that the hottest part of the boiler in operation is near the bridge wall, but the amount of heating surface exposed to the heat is small, while



FEEDING THE BOILER AT THE FRONT

the greater part of the heating surface of the boiler is in the tubes, and the place where the greatest evaporation takes place is the rear of the boiler where the flame enters the tubes.

I have had experience with boilers fed in accordance with each of these methods, and while I have never known of a single boiler being burned that was fed at the front, I have known great numbers being burned which were fed at the rear. The reason is, that the introduction of the supply of feed water at the point where the greatest evaporation takes place, causes the trend of circulation to be changed from rear to front, while it would be better if it were from front to rear.

The less the difference betwen the amount of water evaporated at a given point and the amount fed to the boiler, the more active will be the circulation, since if we should assume that all the evaporation took place at one point in the boiler, and the feed water was introduced at the same point in just sufficient quantity to make up the amount evaporated, there would be no circulation at all. But, if we should assume the same conditions as to evaporation, and introduce the feed water in the same quantity in the part of the boiler opposite the point where the greatest

evaporation was taking place, the circulation would be very rapid, as all the feed water in the process of evaporation would have to pass from one end of the boiler to the other. I think that this will make the point clear.

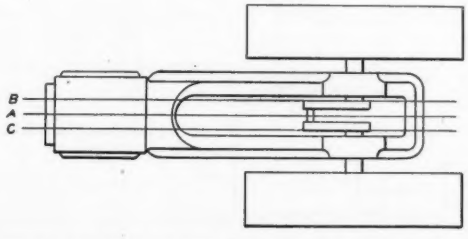
It will be observed that when the feed water is introduced at the rear of the boiler, the sediment will be found piled up over the fire, the very last place we want it, as this is what causes the burning and bagging of the sheets. This is because, as I have stated, the circulation is reversed. I have noticed that when the feed water is introduced in the front of the boiler, the sediment is carried by the trend of circulation toward the rear of the boiler where the blowoff is placed to enable the engineer to get rid of the sediment by blowing off.

Feeding the boiler at the point where the evaporation is the least is followed in locomotive practise universally, because this is a matter that is entirely in the hands of men who are beyond question competent to determine the proper methods. In the case of the locomotive the water enters the boiler at the front, which is in this case the point where least evaporation takes place from the fact that the gases enter the tubes at the fire-box end of the boiler, or just the reverse of the common return tubular boiler.

In the case of water-tube boilers, it will be found that usually the feed water is introduced in the rear of the steam drums, which is evidently the coolest part of the boiler from the fact that here the flue gases last come in contact with the boiler surfaces on their way to the stack. I find therefore that my contention that the place to introduce the feed water into a boiler is the point where the least evaporation takes place, is well supported. Yet I find many plants where the practise is reversed, and as stated before, in some instances with evil results mentioned.

LINING UP AN ENGINE

Kindly tell me how to line up an Ideal high-speed engine, the belt having drawn the shaft out of line.



LINING UP THE SHAFT TO A HIGH-SPEED ENGINE

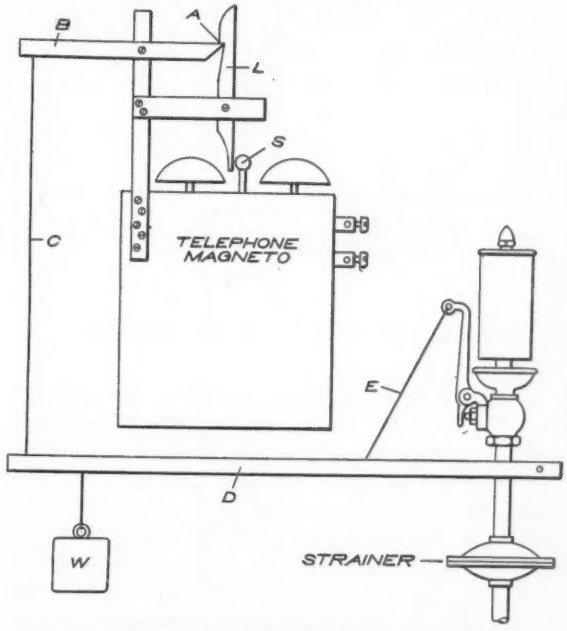
A.—Remove the piston, crosshead and connecting rod; then run a line through the cylinder, centering it in the cylinder by calipering it from the counterbore as shown in Fig. 1 at A. Next, run a line parallel to each crank disk alongside the center line through the cylinder as at B and C and measure at the 2 extreme ends of the engine from the center line to the lines on each side as in Fig. 1. The boxes should be adjusted by the screws or by shims of cardboard or strips of tin until the lines which are parallel with the crank disks are exactly parallel with the center line of the engine. If the boxes are worn out of line, it may be better to rebabbitt the boxes.

WHISTLE TELEPHONE CALL

Many engine rooms, shops, etc., are so noisy that it is almost an impossibility to hear telephone and other signal bells. The sketch shows how one ingenious engineer has overcome the difficulty in a simple manner.

In the case illustrated compressed air is employed as the medium for blowing the whistle and where there is a constant supply available it is preferable to steam.

Whenever the electric circuit is completed it starts the striker S to vibrating and as it hits the lever L at X and the catch upon the lever disengages at A when the weight W falls a short distance and through the cord E opens the whistle valve. The whistle blows continually until the levers have been again placed in their normal position. When using compressed air a strainer should be placed in the pipe as shown, to keep all dirt from getting under the valve. The



ARRANGEMENT OF WHISTLE TELEPHONE CALL

smallest sized whistle which can be purchased will answer for a very large room. If for any reason it is desired to have more than 1 whistle in the same engine room they can be of different tone.

Where natural gas is used for heating in the winter the same arrangement could be used for increasing the heat before arising in the morning and an alarm clock could be made to do the work of disengaging the levers.

S. L. Hills.

LETTERS FROM ENGINEERS

Send us descriptions of ways of doing new things, and new ways of doing old things. Rough pencil sketches and letters are all right; we will fix them up for the printer. All accepted contributions will be paid for when published.

Better Vacuum Obtained by Changing Position of Condenser

A few years ago, in a certain city, a large pumping engine was installed to pump water from the filter into the mains about the city. The height of the water in the filter basin was such as to bring it close to the valves of the pump, so there was but little lift. A surface condenser was in the basement, several feet lower. Figure 1 shows the 24-in. suction A, with the pipes B and B, 6 in. in diameter leading to and from

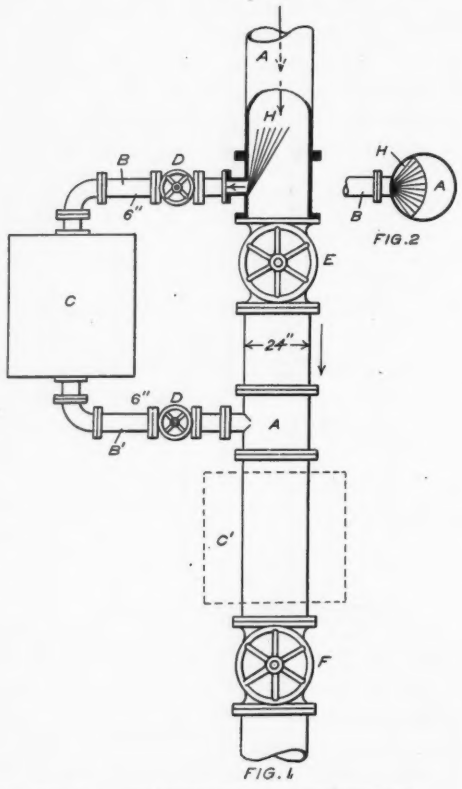


FIG I. ARRANGEMENT OF CONDENSER
FIG. 2. DETAIL OF DEFLECTING PLATES

the condenser C. E is a deflecting valve, and F, a gate valve. The water flows in the direction of the arrows, and through the tubes of the condenser.

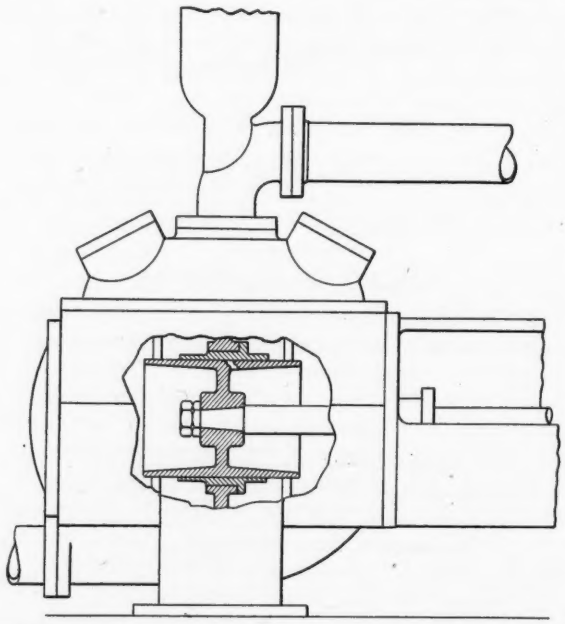
In the layout of the piping it was thought that by closing the deflecting valve E a little, the water would be drawn through the condenser in sufficient quantity to obtain a good vacuum, but such was not the case, as only 22 or 23 in. was obtained. So a sort of scoop was made of steel plated, fitted with lugs, by which it was held in place by capscrews. H shows the position of the scoop in the pipe A, and Fig. 2 is a cross section. It was thought that a greater quantity of water would be deflected into the pipe B, by this means, but the vacuum was helped little or none.

At last the decision was reached to get another condenser with 24-in. flanges at the sides, opposite each other, and place it in the suction as shown at C^1. This was done, and the scoop removed, also the deflecting valve and the pipes BB^1. The water now passes around the tubes and the steam through them. There is an oil separator between the engine and the condenser, and the vacuum is now 27.5 and 28 in.

Tom Jones.

A Pounding Pump

In a 12 and 18.5 by 12 by 18-in. duplex compound pumping engine, the pump commenced to pound on the outboard stroke in the low-pressure cylinder on



THE HOLE IN THE PLUNGER WHICH CAUSED THE TROUBLE

the short lever side some time ago, and all efforts to stop it were of, no use.

It seemed to lose its compression, so we had the valves planed and seats scraped true, as they were somewhat worn, but that did not stop it.

We were about to give it up when we removed

the head on the water end again to see whether the bushing was loose, but found it tight. On starting the pump with the head off, we could hear a peculiar action of air, and feeling around the bushing, found the plunger pretty rough on top, just as she got through the bushing on the completion of the stroke. We shut her down, and on top of the plunger, which is of the solid type, just as the pump completed her stroke and close to the bushing was a hole about 3 in. long and 0.75 in. wide. That settled it; we then knew where our trouble was.

Just about the time the plunger finished its stroke this hole got through the bushing, and the water under 75 lb. pressure rushing through this hole, pushed the plunger on so that the piston on the low-pressure cylinder hit the head with a thud. J. R. Weyher.

Safety Valve Area

I was much interested in Mr. Yates' letter in the July issue in regard to the different rules for finding the size of safety valves, and I agree with him when he says that there should be some standard rule whereby the size of a safety valve could be determined. Although I think if any of the rules he has given are used there will always be sufficient valve area under most any conditions. It is merely a case of one rule allowing a greater margin of safety than another.

Take for instance his own boiler, which has 36 sq. ft. of grate surface and is equipped with 2 3-in. valves; if we were to calculate the size of safety valve for this boiler by the Philadelphia rule which is grate area × 225÷ (gage pressure +8.62), gives 36×22.5÷(80 +8.62)=9.14 sq. in. area of valve. This would be a valve 3.5 in. in diameter which is much less than the boiler now has.

Now to show that this valve is of sufficient size to take care of this boiler we will suppose that the maximum amount of coal burned per square foot of grate surface is 25 lb. and that 12 lb. of water is evaporated per pound of coal. This is an impossibility in practice the rate of combustion being more like 15 lb. and evaporation more like 8 lb., but we will use these figures to be safe.

Then 36×25×12=10,800 lb. of water evaporated per hour or 3 lb. per second. To find the area that will discharge a given weight of steam per second we will use the following formula: area=weight×70÷ absolute pressure=3×70÷(80+14.7)=2.21 sq. in area of opening. This area of opening is not proportioned to the area of the valve but to the diameter and the lift. When a valve has lifted ¼ its diameter the area of opening will equal the area of the valve, but in practice valves have a much smaller lift than this, a larger valve being used with less lift.

The area of opening divided by the circumference equals the lift, hence 2.21÷3.5×3.1416=0.2, or about 3/16 in., if the valve has a flat seat. If the seat is beveled to an angle of 45 deg., the lift will have to be somewhat greater in order to give the same area of opening.

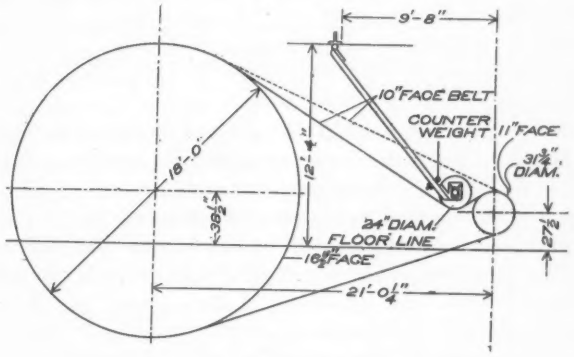
Although some of the United States rules are considered as back numbers, I think the rule used by the steamboat inspectors is good and safe. That is 3 sq. ft. of grate surface to 1 sq. in. of valve area for pop valves, which will give ample area under almost any conditions.

The leading manufacturers of safety valves use this rule in specifying valves for boilers. I think the proper way to find the size of the valve is from the grate surface, as the capacity of a boiler is, to a great extent, determined by the grate surface.

N. S. Campbell.

A Belt Tightener

In your September issue, on page 49, I find what is supposed to be a description of a belt tightener driving an exciter from a cross compound Corliss engine at the Studebaker Works. I am at a loss to know where you got the published sketch. To a practical engineer it would certainly be an outlay worthy of criticism. I am the originator of this scheme, and I do not wish to be criticised by my numerous engineer friends.



CORRECTED ARRANGEMENT OF BELT TIGHTENER

I am enclosing a correct layout of this tightener, and you will note that the action of the tightener is entirely different from what you show. I will further add that before installing this tightener, the belt had to be kept so tight that the exciter bearings were always on a danger limit from overheating, but since putting on this tightener, and having it counterweighted by a counterweight cable (indicated on sketch) it enables the belt to be run very loose, taking off the previous excessive strain on the exciter bearings, and also giving us almost 50 per cent more belt contact on the driving pulley. I would like to further add that this is one of the many instances in our factory where we are using belt tighteners to a good advantage. In many instances we have reduced our belt expense over 50 per cent, and at the same time bettering the condition of the machinery which is driven.

Trusting that you will accept this in the spirit in which it is given, as my only desire has been to correct a possible erroneous conception as to the proper construction of a tightener.

J. L. Hummer.

Fitting Crank Brass

A good method of fitting a crank brass, which I saw used by an old engineer, is as follows:

A new crank pin had been pressed into the crank, and the old brasses, which were babbitted, were used. As the new pin was a little larger than the old the bore of the brasses was filed and scraped considerably. Lamp black was coated on the pin, and each half box was fitted in the manner shown in Fig. 1, in

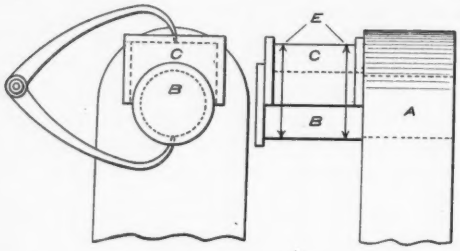


FIG. 1. CALIPERING THE BRASS FOR THICKNESS

which A is the crank, B the pin and C the brass. The calipers touched equally at points E, calipering from from outside of brass to outside of pin.

When both brasses were square and had a good bearing on the pin, with clearance top and bottom, the strap was put on and snugly keyed—Fig. 2—and

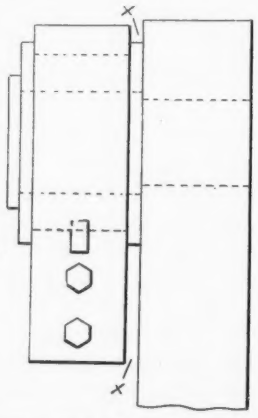


FIG. 2. TRUING THE STRAP PARALLEL TO CRANK

distances, X, X, between strap and face of crank made equal, thereby bringing the strap parallel.

The strap was revolved a few times to see that there was no hitch and then was connected to the rod. It ran fine.

Figure 3 is a good method of grooving the brass, insuring a free distribution of oil. Tom Jones.

Diagram Comment

Replying to L. A. H., whose letter appears in the October issue of Practical Engineer, page 48, I would say:

His left hand diagram measures very closely 3.76 sq. in. area, and the right hand diagram 3.73 sq. in. This gives an average of 3.74 sq. in. area, close enough for practical purposes. The length of the diagrams is 3.3 in., and the average area divided by the length gives the average height of both diagrams. This is 3.73÷3.3=1.13 in. As the scale of spring is 50, 1.13 ×50=56.5 as the number of pounds pressure per square inch acting on the piston, or the m. e. p.

By using the general horsepower formula, and

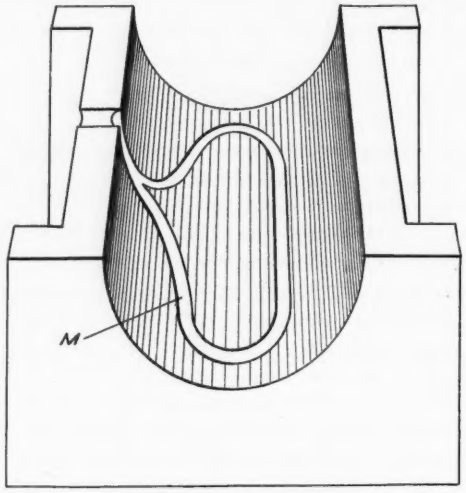


FIG. 3. A GOOD OIL GROOVE

substituting the proper figures, the statement would be like this: P L A N÷33,000=56.5×4×452×144÷33,000=446 hp. of the engine represented by the diagrams in question. The power would really be a little less than 446, for the piston rod area has not been taken into account. The figures are sufficiently close, I think, for the purpose L. A. H. has in mind.

About the only unfavorable feature shown in both diagrams, when all things are considered, is that the exhaust valves do not open quickly enough. I think the eccentric should be given a little more angular advance, and any excess of compression that would be induced by so doing can be modified by adjusting the rods connecting valve to wristplate. By doing this, he will save a little in his steam consumption, as an earlier point of cutoff may be attained, which is just what he at present requires, if economy is an object. Charles J. Mason.

I see in the October issue that L. A. H. shows a set of indicator diagrams on page 48 and asks for the m. e. p., also the hp. I get for the left hand diagram 55 lb. m. e. p. or 386.65 hp. and for the right hand one 54 lb. m. e. p. or 379.62 hp. The diagrams show that the engine is overloaded and he does not realize boiler

pressure as shown by diagrams. Also, I believe that the diagrams would look far better if he would shift the eccentric ahead a little to get events earlier.

L. C. K.

In answer to L. A. H., the indicator diagrams taken from his 24 by 48-in. Corliss engine show that his engine is developing 454.03 hp. and the m. e. p. is 57 lb. on one end and 58 lb. on the other. The cards show too late release, and admission a trifle too early.

F. J. D.

Steam Hammer Trouble

In my charge are steam engines and a steam hammer; the former give no trouble, but the hammer, which is of the vertical type, cuts its cylinder and piston so that there is considerable steam going to waste. I had the cylinder rebored and a new piston put in, but in 6 weeks it was nearly as bad as ever.

The cylinders are 10 in. diameter by 42 in. stroke and 12 in. diameter by 48 in. stroke. The piston rod is 5 in. diameter and the hammer weighs 3200 lb. with a die of 200 to 2000 lb. attached and a similar die used on the anvil. Steam pressure is 100 lb. per square inch. Three pints of cylinder oil in 10 hr. are fed into the cylinder by an oil pump. The piston is fitted with 2 snap rings and delivers a hammer blow of 10,000 to 15,000 lb.

Can anyone suggest a remedy for the cutting?

A. J. C.

Testing Ammonia

I would like to ask in regard to the drawing of ammonia into a glass test tube if this is a good way to test the moisture. I don't see how the man could ever do it, for where he uses 99.99 per cent pure ammonia a sniff from the liquid ammonia line would be likely to put him out of business. I think it would be a better way to take the guarantee of the ammonia people in regard to the purity of the liquid and then be careful not to get any water into the system. I think it would be better if you want to enjoy life a while longer to omit this method of testing ammonia dry.

J. W. Haney.

Your favor enclosing a letter from Mr. Haney received, and in reply to his criticism relative to the method mentioned in the September issue for testing liquid ammonia would say that from his letter it is clear that he is running a compression plant, and never handled an absorption machine, hence does not know the importance of ascertaining at stated intervals the purity of the liquid ammonia distilled from aqua ammonia, because the compression system uses nothing but pure anhydrous, and it is simply a waste of time to test for moisture when the liquid is pure.

If Mr. Haney will read the September article carefully, he will note that the writer says that part of it applies to both systems, but that the article is written principally in the interest of the absorption system. Furthermore, the method mentioned is not new by any means, as the writer and others have used it as far back as 1895. Among those were some of the pioneers in the ice-making business by the absorption system, and one of them was about the first successful absorption ice machine builder in this country, and is extensively engaged in the manufacture of ice at the present time.

I did not explain to be careful not to stand in line with a current of air for fear of being put out of business, as he terms it, because I considered that ordinary common sense would teach one to take a position where the fumes would blow from you. I would add however, that there should be 2 persons, 1 to operate the valve and the other to pay strict attention to the test tube and, if the person operating the valve takes the same precaution in drawing liquid ammonia as he must when drawing a tin-cupful of hot water from a steam boiler under pressure, there will be no trouble.

W. S. Luckenbach.

Ringing Transformer

I should like to get some information from engineers who have had experience with transformers. At the electrical show in New York last week, I saw a small transformer, taking alternating current at 110 volts and stepping it down to 24 volts. The secondary winding was tapped to give 8 volts between first and second binding post, 16 volts between second and third and 24 volts between first and third, this reduced voltage being utilized to ring doorbells and gongs up to 6 in., work door openers, etc.

I should like to make an apparatus of this sort to ring 14 6-in. gongs (Recti) simultaneously every 40 min., but I am unable to figure out what size of wire I need, how many windings on each coil and the size of core required. As I have no instruments for measuring either e. m. f., current or resistance I can't tell what the load is, but I know that a battery of 14 Samson cells connected 7 in series and 2 series in parallel will do the work as long as in A 1 condition.

Engineers knowing the output of the Samson batteries No. 2 will be able to make a close guess at the size of the load from this. What should be the cost of material?

K. H. M.

A Quick Repair Job

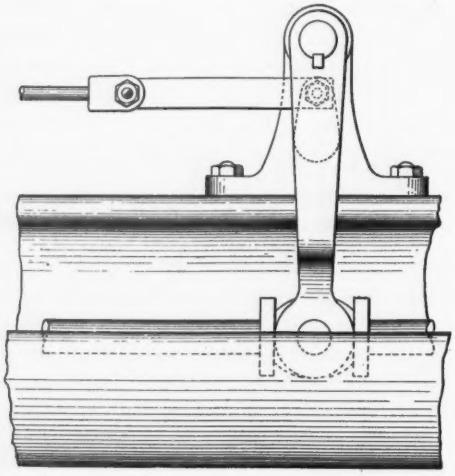
Recently I was employed as engineer in a plant where a battery of 5 horizontal tubular boilers was fed by a duplex pump. There were 2 feed-water pumps in the plant; one of them, being out of commission for general repairs, was dismantled and some parts were at the machine shop.

The plant which was for ice making was using all the steam that the 5 boilers could generate, hence, disaster threatened when the fireman came running up to the engine room stating that the feed-water pump had stopped and he could not get it to start. No wonder it wouldn't, as the link rod on one side was

broken off at the end which connected to the valve stem.

I had the firemen cover the fires with green coal and closed the damper and the steam wasn't long dropping down from 90 lb., which was what we carried, to 50 lb. The city water was turned on to feed the boilers and the engines were slowed down.

It was in the summer time and we were short of ice, so it was up to me to get that pump fixed somehow. I looked around the plant to see what I could find to replace the link rod and dug out a piece of ¼ in. iron plate 2.5 in. wide which had originally been



A MAKESHIFT LINK ROD FOR A DUPLEX PUMP

a pipe hanger; it was about the length of the broken link rod. I drilled holes in the ends to fit the pins and connected up the pump with 2 pieces of pipe for washers, completing the job in an hour, and the pump ran all right for a couple of days until the other pump was put into service.

In the same plant one of the ice machines, which was a 125-ton driven by a 250-hp. Corliss engine, one evening stopped without warning. Thinking that someone had closed the throttle, I asked the oiler, who had been standing by, why the engine had been shut down, and he said she had shut down herself.

Finding the throttle was open wide, I closed it and tried to start up again, but could not do so. I looked the engine over, found everything all right and came to the conclusion that the trouble was in the throttle valve. I closed the stop valve on the main, pulled the throttle valve to pieces and found that the disk had dropped off the stem and closed the passage to the steam chest. I removed the disk, replaced the bonnet of the throttle valve and started up on the stop valve in the main and ran that way until I got a new disk.

S. J. Hogan.

A CUBIC INCH of mercury weighs 0.49 of a pound, therefore 28 in. of mercury means 28×0.49=13.72 lb. back pressure removed, or 14.7—13.72=0.98 of a pound back pressure absolute on the turbine.

THE INFLUENCE OF HUMIDITY OR MOISTURE IN THE AIR

The influence of humidity on human comfort is very clearly presented in a publication entitled Healthful Air just issued by The New York Blower Co., of Chicago, from which the following extract is taken:

Moisture plays an all important part in human comfort. The presence of aqueous vapor is not accidental; it is present in the atmosphere on every portion of the globe. But it varies greatly with every change in temperature. On an average, air contains about 1 per cent of its volume in the form of water vapor. But the total relative weight which can be held in suspension increases rapidly with the temperature.

Thus air at zero with a relative humidity of 100 per cent would if heated to 80 deg. without the addition of moisture, have a relative humidity of only 4 percent, that is it would contain only 4 per cent of the amount which would be required to saturate it. Its absolute humidity, or the total amount of contained moisture, would remain constant except as affected by the increased volume of air. Half a grain of water is all that is required to saturate the air at zero but over 20 times as much is necessary when the temperature is 80 deg. If the air is taken at a temperature of 20 deg. with 70 per cent humidity and raised to 70 deg. the relative humidity would be about 12 per cent.

It is however by the relative humidity and not by the absolute humidity that we measure comfort. Relative humidity which is most simply expressed by the reading of the wet bulb of the hygrometer is in fact the real expression for the sensible heat; for that which we really feel as compared with that which the ordinary dry bulb thermometer shows us.

A healthy man, under good normal conditions of temperature and humidity, gives off a constant average quantity of heat, of which somewhat less than 10 per cent is expended in evaporating water from the lungs, somewhat less than double this amount in evaporating water from the skin, while over 70 per cent is radiated and conducted from the surface of the body.

If anything interferes with the prompt and regular escape of heat, discomfort soon results. As the greater portion of the heat loss is by condensation and evaporation, the rapidity with which this process goes on depends upon the capacity which the surrounding air possesses for taking up moisture. The importance is therefore manifest of maintaining constantly within inhabited buildings, that degree of humidity which is most conducive to comfort and most economical as regards the cost of heating. It is the wide range betwen summer and winter outdoor temperatures and the corresponding range in relative and absolute humidity that compels the use of artificial means to secure adequate and controllable results.

QUESTIONS AND ANSWERS

Our readers are invited to send in their troubles and problems; also to answer questions which are asked. All letters must have name and address of writer, which will not, however, be published. If answers are wanted by mail, send stamp for reply.

Tempering Brass

What is a good process for tempering sheet brass to make it springy? G. F.

Babbitting Bearings

I have a cross compound air compressor with babbitted crankpin boxes. The main bearings are cut through quarterwise, or at an angle of 45 deg., and are also babbitted. Please tell me how to babbitt both.

2. Is it all right to adjust the length of the piston rod to keep the clearances even, as there is no way to shim the boxes. E. B. W.

A. 1. It is assumed that a type of shell box is used,

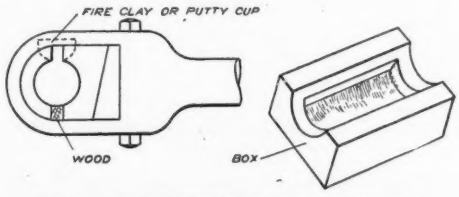


FIG. I. CONNECTING ROD END AND BOX

in which the babbitt rests between retaining flanges, on all sides of the box, as shown in Fig. 1. If the babbitt fits around the box, as in Fig. 1, a new sleeve or liner will be required.

The crankpin boxes can be babbitted on the pin if so desired. Care should be used to fill the oil hole in the pin with a pine stick if a center oiler is used. Then give the pin a good coating of oil.

Raise the key as far as possible, or drop the wedge if the solid end construction rod is used.

Remove all old metal. Replace the boxes, placing a piece of wood or leather between the boxes at the bottom as in Fig. 1.

Around the opening at the top of the boxes fill 1 side the same as at the bottom. A cup made of fire clay or putty can be built around the other side of the boxes and the metal poured into this.

When the boxes are cool enough to handle, remove them, and thoroughly clean both the boxes and the pin, remembering to take the wood from the oil hole if it was filled. The boxes can then be scraped to a good fit and the oil grooves cut.

Another method is to remove the boxes from the pin and babbitt them on an arbor.

Make an arbor the same size as the crankpin. Place the box in a vise, and the arbor in the box as in Fig. 2. Between the arbor and the box, as shown in Fig. 2, place leather strips or putty, to raise the arbor off the flanges of the box, or the pin would bear on the flange at the sides of the box, the thickness to insert here to be determined by the judgment of the workman.

When the whole has been placed in the vise, secure the arbor to the box by a hand clamp.

The metal can be poured from either end. Care should be taken that no water is in the box or any chance for it to drop into the hot metal, as it will cause the metal to fly in all directions.

The main bearing can be readily babbitted in place in most cases, if the construction is such that the weight can be removed from the bearings by jacking up the shaft.

Take out the several parts of the bearing and remove the old metal. See that the anchor holes are clear and will properly hold the babbitt.

Give the shaft a good coating of oil to prevent the molten metal sticking to it. Replace the bearing, with liners inserted between the several sections of the box,

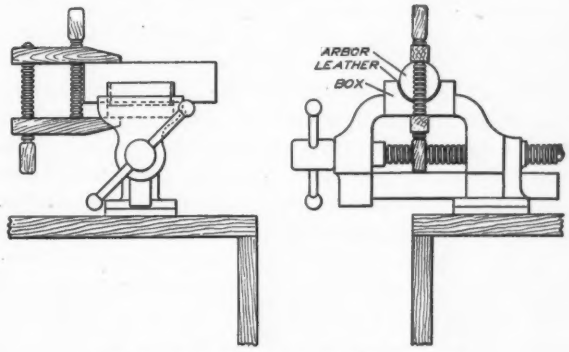


FIG. 2. BABBITTING A CRANKPIN BOX

and between the shaft and the parts of the box, as was done for the crankpin.

Be sure to have a sufficient quantity of babbitt melted to pour the box at 1 operation; the metal will not flow evenly over the whole surface, if more than one pouring is used.

After the boxes have cooled, remove them and scrape to a good fit, when the necessary oil grooves can be cut.

2. It is good practice to equalize the clearance by screwing the piston rod into or out of the cross head as required.

Leveling and Lining Shafting

1. I have a room in which there are no posts, only the beams overhead. The room is 100 by 50 ft.,

and the 3-in. shaft is to run parallel to the building. How shall I get it so?

2. I have also a 4-in. shaft on the first floor for heavy machinery, which is to be set not over 12 in. from the floor, and is an extension for 25 ft. of a line already in place. How shall I put the shaft in place so that it will connect to the present line with a coupling and have no wobble or bind?

3. I have a third short shaft, which is to be set at right angles to the main shaft, which is 15 ft. from the countershaft. How can I get it just at right angles?

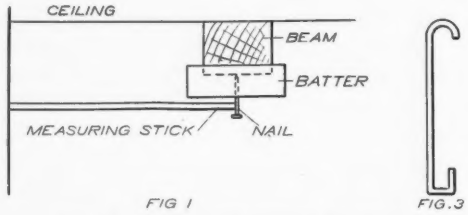


FIG. 1. LINING SHAFTING TO WALL

FIG. 3. HOOK FOR STRAIGHT EDGE

4. How can I locate holes for a belt which is to pass through the floor?

A.—One method of running shafting parallel with the wall of the building is illustrated in Fig. 1.

On the beam, nearest to the wall with which it is desired to have the shaft run parallel, nail a short piece of stick or board, called a batter. Locate the center of the bottom surface of the beam with a caliper and drive a nail at the center. Then with a stick or steel tape, measure from the face of the wall to the nail. At the other end of the wall drive a nail into the beam at the same distance from the wall as indicated by the measuring stick or tape.

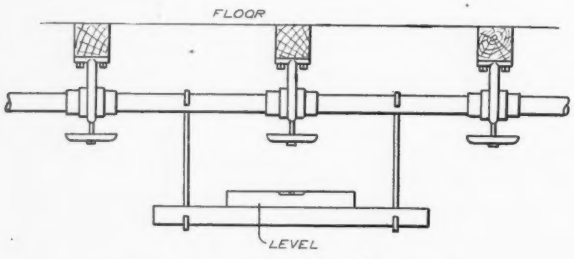


FIG. 2. LEVELING UP IN BEARINGS

Then secure a line to 1 of the batters, cutting the center of the nail; continue the line along the room to the other batter, where the other end of the line is secured, also cutting the center of that nail.

As modern shaft hangers are adjustable in both directions, it is assumed that such hangers will be used. Put up the hangers about right, and move the bearings in the hangers until the line cuts the bearings exactly in the center. When all the hangers are secured, the shaft can be lifted into the bearings, care being taken to clean both bearings and shaft before placing the shaft in position.

Having the shaft in position, it can be leveled as follows: Make 2 hooks of bar iron, say 3 ft. long, as in Fig. 3. Let the hooks pass over the shaft as in Fig. 2, using as long a distance between the hooks as convenient to work with. Lay a straight edge in the hook pockets intended for its reception, and along the straight edge a level. Then by turning the ver-

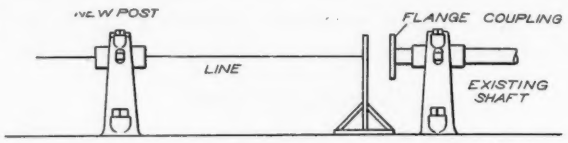


FIG. 4. LEVELING UP FLOOR SHAFT

tical adjusting bolts in the hangers the shaft is brought level.

Another method of supporting the level, is to suspend the straight edge by slings made of suitable cord. Another way, is to place the level on the shaft itself. The method using the level on the straight edge is more accurate, however.

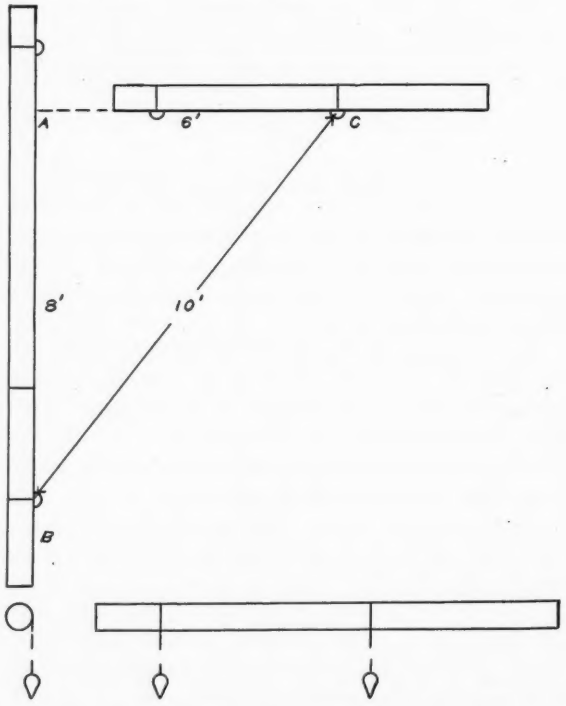


FIG 5. SETTING SHAFTS AT RIGHT ANGLES

2. The method of locating the center of the shaft parallel with the building can be used also to locate center line of the 4-in. shaft. The lathe center, on which the shaft was turned, can be used to measure to in finding the vertical distance from the floor for the center line of the shaft. Set up a batter at each end of the required new length of shaft and proceed the same as before in setting the post supports.

In this case place the level on the shaft itself when leveling. If any of the adjusting screws are turned up as far as possible before the shaft is level, it will be necessary to place a shim between that post bearing and the floor to get the required adjustment.

3. To get 2 shafts at right angles to each other, drop 2 plumb lines from each shaft at points well apart, so as to establish the lines of direction of the shafts on the floor. Prolong these lines of direction until they intersect as in Fig. 5 at A. From A lay off 8 ft. on one line and 6 ft. on the other, as to B and C. The distance BC should be 10 ft. if the shafts are at right angles. If not, one shaft or the other must be moved until with AB 8-ft. and AC 6 ft., BC is 10-ft.

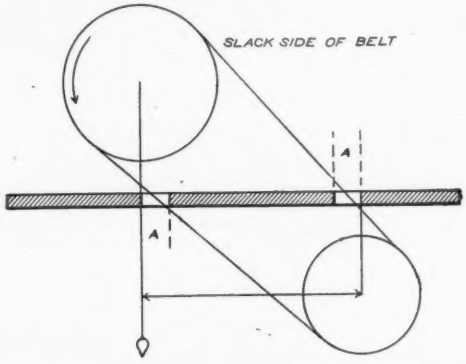


FIG. 6. FINDING POSITION OF BELT HOLES

4. To find the location of the belt holes lay out their location on paper to scale something like this:

Draw horizontal lines to represent the floor and ceiling. Then drop a plumb line from the center of the upper shaft through the floor, by boring a small hole, and locate this line on the drawing. Below the floor, measure from this plumb line to the center of the pulley under the floor, also from the center of the pulley upward to the ceiling. Then measure above the floor to the center of the upper shaft and lay off these distances on the drawing. Lay out the shaft centers and draw in the pulleys. Next draw lines from the pulleys to represent the belt and measure off on the drawing from the plumb line to the crossings of floor, ceiling and belt. Lay these distances out on the floor and allow 3 or 4 in. on each side of the crossing points and cut the holes. The hole for the slack side of the belt should be larger than the other, and can be enlarged as circumstances dictate.

Difference Between Steam and Water Pressure

J. S. R.—If a boiler is tested with 80 lb. water pressure, what steam pressure could it stand? Should a boiler burst under water pressure, would it do much damage?

A.—The rule for hydraulic test of boilers varies in different cities. In some places the hydraulic pressure is carried up to 1½ times the steam pressure, and in some places, 2 times the steam pressure. Usually 1½ is sufficient; hence, if the boiler is tested with 80 lb. water pressure, it should be safe for 50 lb. steam pressure. This, however, is not a conclusive test, since there may be weak spots in a plate which the hydraulic pressure will not reveal.

If a boiler bursts under water pressure, the water being not over 212 deg. F. in temperature, there would be no dangerous results. The water would simply rush out at the leak.

Compressor for Air Lift Pumping

W. P. F.—For a 6-in. drilled well about 300 ft. deep, in which the water stands 20 ft. from the top of the well, we wish to carry the water 75 ft. horizontally and to have a flow of about 250 gal. a minute. What size of air compressor, compressor tank and air pipe will be necessary and what will be the horsepower of the compressor and the engine to drive it, which will be gasoline?

A.—In order to get the size of compressor and engine it will be necessary to figure out first the air pressure and the amount of air required. The water level when pumping will always stand lower than when quiet. In order to be on the safe side, if we allow 30 ft. drop of water when pumping, and allow for lifting the water 5 ft. above the ground surface, we shall have 55 ft. of lift above the water surface, and for a run of 75 ft., assuming a 3-in. pipe, there will be a friction head of about 4 ft. This would give us 39 ft., which, for the sake of safety, we will call 40 ft., as the lift.

In air lift pumping it is usual to submerge the pipe to a depth of twice the lift, or 80 ft. The pressure required will then be 0.7 times the total vertical height of the air pipe, which is 40+80=120 ft. The pressure will then be 0.7 of this, or 84 pounds to the square inch. Of course, when starting up, the pressure will have to be higher than this.

A flow of 250 gal. a minute would be 27.8 cu. ft., and to get the cubic feet of air required per minute we multiply the cubic feet of water to be carried by the height of the lift above the water surface and divide by 20. This gives us 27.8×40÷20=55.6 cu. ft. of air used per minute. To find the size of air pipe required, allow 20 ft. a second velocity in the air pipe, or 1,200 ft. a minute. The 55.6 cu. ft. of air already found is the free air before it is compressed. Assuming this to be compressed to 84 lb. pressure, the volume will be decreased to 55.6×15÷99=8.4 cu. ft. The internal area of pipe required will then be 8.4÷1,200 and multiplied by 144 to reduce it to square inches, which gives us 1.01 in., or, from a table of areas of piping, this will be 1¼-in. piping for air. The area of the flow pipe for the water is about 6.25 times that for the air, or, in this case, 6.32 sq. in., which will be 3-in. pipe. It will be safer to use 3½-in. pipe to cut down friction loss. To supply 55 cu. ft. of air at 90 lb. pressure, which will be the value required at the compressor, as the air will lose about 6 lb. in trans-

mission from compressor to the bottom of the well, it will require a 6 by 7-in. compressor, which can be either single-stage or 2-stage. For 90 lb. probably the 2-stage is to be preferred, and this will need 14.7 hp. per 100 cu. ft. of air supplied a minute, or, for 60 cu. ft., 9 hp. At an efficiency for the machinery of 75 per cent, the horsepower required from the engine would then be 9÷.75=12 hp.

Power of Engine, Boiler and Dynamo

W. K.—1. What is the horsepower of an engine with cylinder 19 by 18 in., running at 200 r. p. m., at 90 lb. steam pressure? 2. How do you find the size boiler needed for this engine? 3. What is the power of a dynamo making 200 r. p. m. and delivering 261 amp. at 575 volts?

A.—1. Employing the usual formula, the horsepower of an engine such as described, is 113.4. In this calculation we assume that the mean effective pressure is 45 lb. In the best practise, it is possible to obtain a pressure slightly higher than this.

2. The size of boiler depends on a number of considerations. Different boiler makers give the same rating to boilers that in many cases have different capacities. It is customary to have more boiler power than engine power, as this is conducive to economy. The exact surplus of horse-power in the boiler over that of the engine depends in a large measure upon the desire of the owner, and also upon the way in which the steam piping is laid out. With a long line of piping, more boiler power is required; similarly, if there are several valves, bends and other obstructions in the steam pipe more boiler power is necessary. In good practise, with a short line of piping, a reserve of 10 h. p. is ample. Under ordinary conditions, it is better to allow from 15 to 20 reserve. This would make the boiler horsepower about 135.

3. The output of any generator measured in kilowatts is obtained by multiplying the number amperes of current by the number of volts representing the pressure. This gives the number of watts, and divided by 1,000 gives the number of kilowatts. In this case we have 261 multiplied by 575 and divided by 1,000, which gives 150.075 kilowatts.

Preventing Boiler Scale

O. W.—1. What should be used to prevent scale, formed of the following elements?

Organic and volatile matter.....	7.2%
Calcium carbonate	13.4%
Calcium sulphate	71.7%
Magnesia	1.3%
Silica	5.2%
Iron oxide and Alumina.....	1.2%

2. Is kerosene good as a scale preventer?

A.—1. The best preventive for the scale that you mention is bicarbonate of soda. This, with the use of an open feed-water heater and a frequent blowing out of the deposit from the boiler, and with a good use of the surface blowoff, should prevent all difficulty. In cooling off the boiler you should be careful not to blow off the water while the boiler is hot, as if you do this so that the scale deposit comes in contact with the bottom plates while they are still hot it is liable to bake into a hard scale.

As to the amount of bicarbonate of soda to use, it should be such that the soda is about the same as the amount of solid matter in the water. This you can only tell by having an analysis made of the water to see how many grains are deposited by the gallon.

2. In regard to the use of kerosene, it is doubtful if it will be of much value, as all it can do is to coat the deposit of scale with grease so that it does not adhere to the iron. If, by any possibility, the deposit becomes baked onto the iron the oil contained with it will make it very much harder to remove.

Induction Coil Current.

B. H. M.—Will you please inform me the kind of current given by the secondary of an induction coil?

A.—The current given out by the secondary of an induction coil is alternating, but with the wave of electromotive force much higher on one side of the zero line than on the other. When contact is made in the primary, it sets up electromotive force in the secondary in one direction, and when the contact is broken, the electromotive force set up in the secondary is in the opposite direction, but these 2 are not of equal value.

Pressure for Throttling Engine

L. A. F.—When running an engine having a throttling governor, which would be the more economical pressure to carry, 60 lb. or 100 lb., when 60 lb. will do the work? 2. Does the superheat obtained by throttling the steam amount to anything when the pressure is 100 lb. and it is throttled down to 60 lb. by the governor? 3. Which is the more economical method of running injectors: to run one at maximum capacity or to run two injectors at minimum capacity, and thus heat the water delivered to a higher temperature? No heater is used in either case. 4. I have a fuse-block marked 100 amp., 250 v. I am running 110 v. through this fuse. Will it stand more than 100 amp? If so, please show me how to figure it out. If not, why do they mark the volts?

A.—1. If 60 lb. steam pressure will do the work it will pay better to run your engine at that pressure, since the amount of superheat gained by throttling will be but small and the extra cost of making the high pressure steam will be considerable. The chances are that your boiler will make steam sufficiently wet so that the throttling will not much more than dry out the moisture, leaving the steam barely dry, and you can accomplish practically this result by using a separator next to the engine at less expense. This will also answer question 2.

3. With no heater in use the probability is that two

injectors, run at a low capacity, so as to give a high temperature to the feed water when it enters the boiler, will be more economical than running a single injector at its maximum. There will also be less likelihood of the injector breaking and causing continual stoppage of the feed.

4. A fuse block marked 100 amp. should never be used to carry larger current than that. The amount of current that can be safely carried depends on the size of the connections and the amount of contact surface allowed on the block, and the cross-section of connections needed will be the same, no matter what the voltage used. To provide for a high voltage it is necessary to use a wider distance between the terminals of opposite polarity and to provide better insulation throughout the block. A fuse block built for 250 v. will, of course, carry 110 without difficulty, but one built for 110, although it will often carry 250 safely, will not be safe for 500-v. circuits.

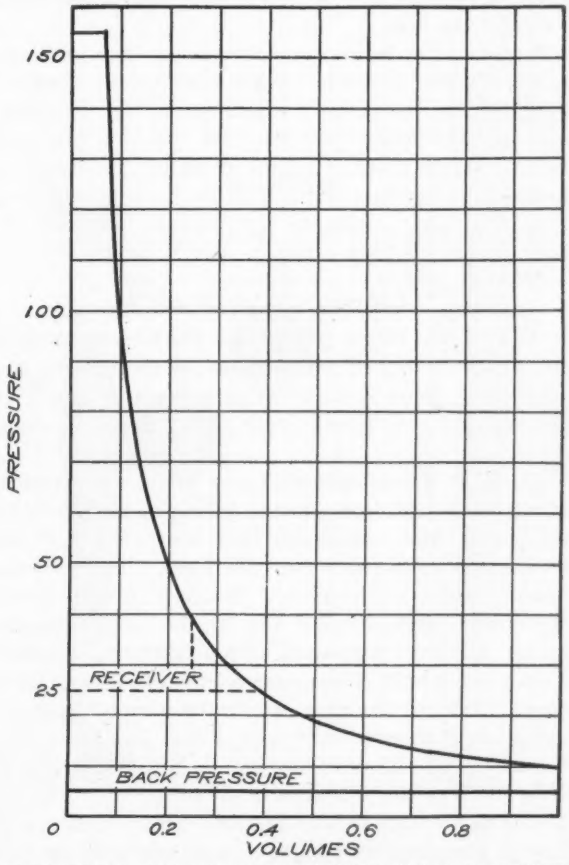
Compound Engine Receiver Pressure for Equal Load In Cylinders

My engine is cross compound 20 and 40 by 42 in. running 92 r.p.m. with boiler pressure of 140 lb. and vacuum of 20 in. How can I figure the receiver pressure so that the power of the low-pressure cylinder shall equal that of the high-pressure? V. B.

A.—The only way to decide on what receiver pres- will give equal work in the 2 cylinders of a compound pound engine is by a trial method. If you know that the engine cuts off at normal rating, which will be about ¼ stroke, then there are 4 expansions in the high-pressure cylinder. The expansion beyond the high-pressure cylinder takes place partly in the receiver and partly in the low-pressure cylinder. The total expansion from the high-pressure cylinder, in receiver and low-pressure cylinder will be equal to the ratio of the area of the low-pressure piston to the area of the high pressure piston.

In your case this is $40^2 \div 20^2 = 4$. In the case that you have, for the work to be equal in the 2 cylinders where the stroke and speed are the same, the mean effective pressures must be inversely as the areas of the pistons; i. e., the high pressure cylinder must have a mean effective pressure 4 times that of the low-pressure. The mean effective pressure in the high-pressure cylinder will be equal to: Initial pressure divided by the ratio of expansion times (1+hyperbolic logarithm of the ratio of expansion, which we have assumed to be 4) minus the receiver pressure. The low-pressure mean effective pressure will be: Receiver pressure divided by ratio of expansion, times (1+ the hyperbolic logarithm of the low-pressure ratio of expansion), minus the back pressure, which, in your case, is 5 pounds. We have seen that the mean effective pressure in the low-pressure cylinder must be ¼ that in the high-pressure. To get the 2 values we have to use a system of trial.

Draw the theoretical total card with an initial pressure of 155 pounds absolute, back pressure of 5 pounds, cutoff ¼ the high-pressure stroke, which equals 1/16 the low-pressure volume. This area is divided by the receiver pressure and we have to assume different values for the receiver pressure and figure out the 2 mean effective pressures to see where they come. The first trial may come too high or too low, then we have to assume another value for the receiver pressure, either lower or higher, and try again, and in this way keep on calculating until we find a receiver pressure which is about right to give the proper ratio of mean effective pressures.



THEORETICAL DIAGRAM TO DETERMINE RECEIVER PRESSURE FOR EQUAL LOAD IN CYLINDERS

Initial pressure 155 lbs., back pressure 5 lbs. (equals about 20 in. vacuum). Assume cutoff at ¼ stroke in the high pressure cylinder. The volume of this in terms of the low-pressure cylinder would be 1/16, since the low- pressure cylinder has 4 times the area of the high pressure.

Taking the stroke as 1, the cutoff for the theoretical card of the entire engine would then be 0.0625. The low-pressure terminal pressure at the end of the card will be 1/16 the initial, or $155 \div 16 = 9.69$. The rest of the expansion curve is drawn in by the regular method from the equation PV=a constant. The final volume in the high-pressure cylinder will be 4 times the volume at cutoff, or 0.25.

We assume a receiver pressure that will divide the card as nearly as possible into equal areas. Take this first at 25 lb. absolute. The mean effective pressure for the high-pressure cylinder will then be 155÷4×(1 + the hyperbolic logarithm of 4)—25=67.5 lb.

Initial pressure in the low-pressure cylinder is 25 lb. and terminal pressure is 9.69. The ratio of expansion will, therefore, be 25÷9.69=2.58. The mean effective pressure in the low-pressure cylinder will then be 25÷2.58 (1+ the hyperbolic logarithm of 2.58)—5=13.88 lb. This value times 4 should equal the high-pressure mean effective pressure. 4×13.88=65.52. This is about right, but the receiver pressure is a little too low.

If we try it at 26 lbs. we find that the high-pressure mean effective pressure equals 155÷4×(1+1.386)—26=66.5, and the ratio of expansion in the low-pressure cylinder equals 26÷9.69=2.68. The low-pressure mean effective pressure equals 26÷2.68×(1+0.986)—5=17.2. Four times this equals 68.8, so that 26 is a little too high. Evidently 25.5 absolute is about the right pressure. This would be 10.5 lb. gage.

Lighting Circuit Wire

W. W. K.—Please give proper size of wire for 250-volt direct current circuits, one using 500 amperes, the other 300. Wire is to be in conduits and length of line is 270 ft., the power being used for motors along the line.

A.—The size of wire that you would use depends, of course, on the drop you are willing to allow. With 250 volts at the switchboard it is safe to allow 10 per cent or 25 volts drop over the lines. The rule for finding the size of wire is: Multiply 10.8 by twice the transmission distance and by the current in amperes. Divide this product by the volts drop allowed. This gives for the 500-ampere circuit 10.8×540×500÷25=116,700 circular mils, which the wire table shows to be larger than a No. 0 wire. This should be reinforced by No. 10 wire, so that a No. 0 and No. 10 wire run together will answer the purpose, or a standard cable with an area of 116,700 circular mils can be used. For the 300-ampere circuit the circular mils would be 3/5 this, or 70,000 circular mils, which is larger than a No. 2 wire, and a No. 14 should be used to reinforce it. Probably it would be cheaper in the running to use No. 1 than to bother with the two wires.

Joy vs. Stephenson Gears. Setting Alternator Brushes

F. L.—1. What are the advantages and disadvantages of the Joy valve gear compared with the Stephenson link motion?

2. What is the method for setting the brushes on the rectifying commutator to a single-phase alternator?

A.—1. One advantage of the Joy motion is the dispensing with the eccentrics, which have considerable friction and frequently give much trouble. It gives a rapid opening and closing motion and less compression than the link motion. It also gives a more nearly equal cutoff for all positions, also maintains the lead constant. Its numerous small parts are liable to work loose and the position of the parts makes the examination of the crank pin and crosshead difficult when running.

2. The brushes should be set the same as on direct current machines and rocked far enough ahead to bear on the commutator at the point where the e. m. f. is lowest.

Rebounding Pump

E. W.—Please state the cause for a pump rebounding while running. I have a duplex pump, high and low-pressure compound. When the pump takes the out stroke and cuts off before return stroke, it will go forward again about 1 in., which causes the valves to knock.

A.—It would be advisable to examine the steam pistons, ascertaining if they are tight, allowing no leakage, as a leak will sometimes cause the valves to knock. The condition of the water valves should be tight, as they might leak and so have no cushioning effect, causing a knock. Again, the air chamber, if one is provided, may be full of water. If so, a recharging with air may avoid the knocking.

EDUCTOR CONDENSERS

This is a new type of apparatus developed by the Schutte & Koerting Co., of Philadelphia, and arranged to work with absolute certainty under all conditions of load variation without the assistance of an air pump. The arrangement of one of these systems as employed as Collegeville, Pa., for the Schuylkill Valley Traction Co., is shown in the illustrations. These condensers are used on reciprocating compound engines of 750 rated horse power each, which are at present loaded to 1,000 hp.

A 12-in. eductor is used for each engine. Water comes from the creek to a well by gravity and is raised by a centrifugal pump having a wheel 20 in. in diameter and 12-in. face to the stand pipe which supplies cooling water to the condensers. The suction lift of this pump is 8 ft. 5 in. and it discharges against a head of 33 ft. 8 in. The water level is maintained in the standpipe at a height to give a head on the eductors of 20 ft. Pumping the water into an open top standpipe gets rid of the air and gives practically solid water in the eductor pipe.

Two centrifugal pumping units are installed in a pit below ground level in order to give a less suction lift. The eductor condenser is installed on a level with the engine exhaust pipe where it is convenient to get at and involves the least possible exhaust piping.

An automatic water check is used which is positive in its action so that it is impossible to flood the engine cylinder no matter how irregular the load may be, and an automatic free exhaust valve to atmosphere is

provided to take care of the steam should anything happen to cause the water check to close. This relieves the engine of back pressure until the water check again opens, when the free exhaust valve will shut down and be held by vacuum.

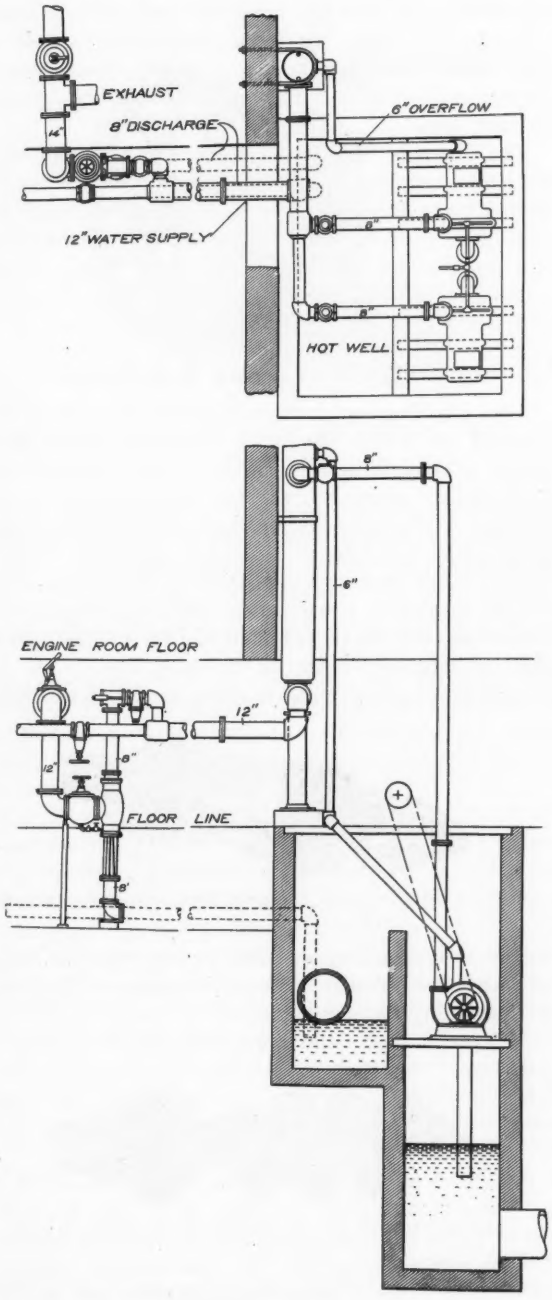


FIG. 1. CONNECTIONS OF EDUCTOR CONDENSER

The construction of the eductor condenser head is shown in Fig. 2. Water comes in at the upper end of the condenser and steam at the side through the water check valve. The stream of water takes up the steam and condenses it, discharging downward through the foot elbow. In case any water attempts to escape to the exhaust pipe, the water check valve closes and the vacuum being relieved the free exhaust valve will immediately open.

In cases where there is a natural fall of water of from 8 to 15 ft. above the top of the condenser, a steady vacuum can be obtained without the use of the pump by the use of the induction type of condenser. In this the position of a sleeve over the exhaust openings is regulated by means of a gear and pinion at the top of the condenser. Adjustment is also made

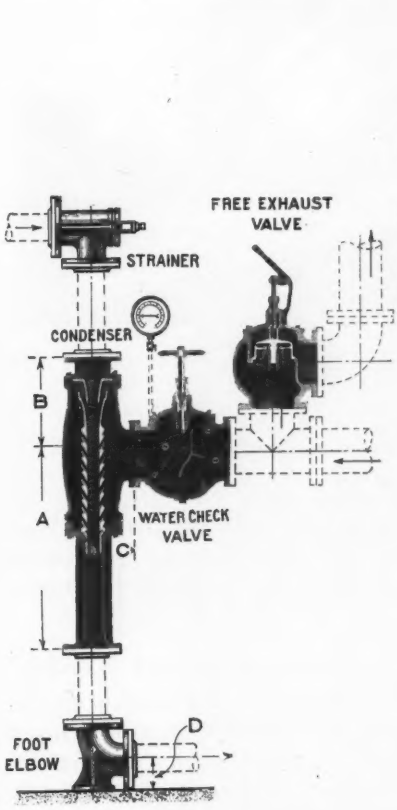


FIG. 2. SECTION OF EDUCTOR CONDENSER HEAD

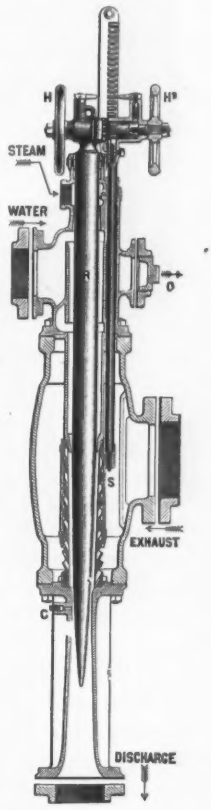


FIG. 3. SECTION OF INDUCTION CONDENSER HEAD

of the setting of the center spindle or water ram so that the amount of steam and water being used are properly proportioned. The condenser will then operate automatically so long as the load remains approximately constant.

This apparatus can be arranged to lift some part of the water required itself, but most of the water needed should come to the condenser under pressure. When all the water is supplied under pressure, the opening marked "Steam" is blanked off, and also the opening C. If water is taken under suction and pressure water used for starting, the pressure water is connected at opening marked "Steam" and the opening C is blanked. When water is taken under high suction and steam used for starting, a check valve is attached to the opening C and the overflow pipe from

this check arranged to discharge free to air or into the main discharge pipe.

Where plenty of cooling water is not available some means must be employed for recirculating, which, of course, implies the cooling of the circulating water. A system of spray nozzles has been devised by the Schutte & Koerting Co. which has given gratifying results. Figure 4 shows a set of these in use

FIG. 4. SPRAY NOZZLE INSTALLATION FOR COOLING THE CIRCULATING WATER

at Ogontz, Pa., where it was impossible to run the plant condensing for 8 months of the year without the nozzles. The water would get boiling hot, but since putting in the spray nozzles the plant has been run continuously without difficulty, the temperature of the water being kept down to 80 and 85 degrees even through the summer months.

THE COMMON SENSE EXHAUST HEAD

It is well known that centrifugal force is proportional to the weight of the body in motion, hence if a mixture of water and steam be given a whirling motion, the water will be thrown outward and, if in a circular case, the water will strike against the sides and be separated from the steam. In the Common Sense exhaust head, the steam enters at the top on a tangent to the circle and sweeps around the inside of the head with a whirling motion. Particles of water and grease are thus thrown in contact with the inner walls of the entire head, these walls forming a large condensing and collecting area which extracts all water and grease.

These run by gravity to the drip outlet below. The steam escapes through a large central opening which is formed by a tube extending downward from the center of the top. The length of this inner tube is 3 times the diameter of the inlet pipe, so that the steam passes several times around the head before escaping from the exhaust opening, an arrangement which acts as a trap to take water out of the steam. The large area of the shell acts as a condensing surface and to collect particles of water and oil, which fall to the bottom of the exhaust head, where they never come in contact with the entering or outgoing steam; the steam is always passing in the same direction so that there are no countercurrents to cause pressure on the inlet pipe.

Besides being a perfect trap so that nothing but dry steam escapes to the outer air, this exhaust head is a perfect muffler, the steam expanding to such a large volume that it escapes in a steady, quiet stream without puffs or noise. The outlet area is 2 to 3 times the inlet area.

The Common Sense head is made of heavy galvanized iron which will not rust and as no pressure can be exerted there is no chance for the head to break or go to pieces. All joints, seams and attachments are both riveted and soldered water tight. This device is made for attachment to pipes from 1 in. up to 20 in. diameter, by Strandwitz & Scott, of Camden, N. J.

LITTLE GIANT TUBE CLEANERS

One of the great problems in power plant operation and one which affects the efficiency of the plant is how to keep the tubes of boilers clean. Clean tubes are equally important, whether the boiler be of the fire-tube or the water-tube type, and the Poole Manufacturing Co., of Albany, N. Y. has, therefore, devised apparatus for both types of boilers. The Little Giant for water-tubes is a mechanical cleaner having a head driven forward by a spline shaft set in the hollow shaft of a rotary engine as shown in Fig. 1. It has a star-shaped point followed by a series of revolving

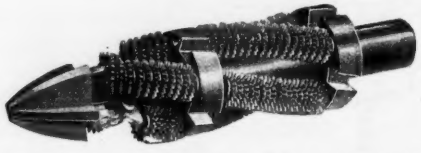


FIG. 1. LITTLE GIANT CLEANER HEAD FOR WATER-TUBES

cutters mounted in spirals and arranged so that as the cleaner moves forward the entire surface of the tubes is thoroughly cleaned of scale.

Figure 2 shows the head used for fire tubes, the

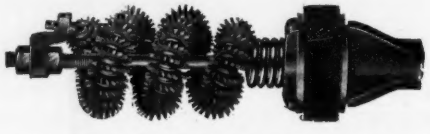


FIG. 2. LITTLE GIANT FIRE-TUBE CLEANER HEAD

series of cutters being used to actually cut the scale and soot from the tube surfaces. The cutter wheels are the same as those used on the water-tube cleaners and are arranged so that they revolve as the cleaner is operated back and forth in the tube. A steel wire brush follows the cutters to brush off the scale and soot that has been removed. By tightening or loosening the nut at the front end, the cleaner may be made

to fit the tube exactly, and pushing this cleaner through once is all that is required.

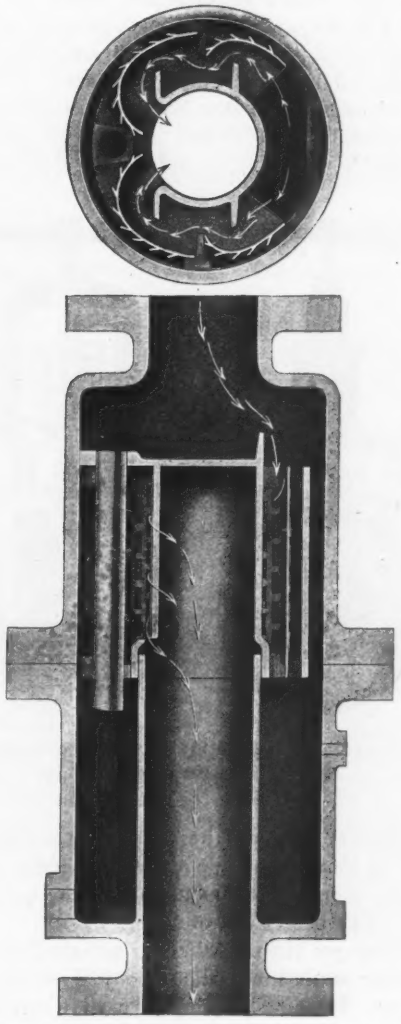
For driving the water-tube cleaners, the Little Giant rotary engine is furnished to be operated by steam or compressed air. This is placed directly in front of a tube, so that the power is applied immediately to the shaft of the tube cleaner. Just enough water is used with the cleaner to rinse the tubes and carry away the scale that is removed. The cleaner for fire-flues is hand operated.

FIG. 3. LITTLE GIANT MOTOR FOR DRIVING WATER-TUBE CLEANERS

STRONG STEAM AND OIL SEPARATORS

These are offered to the trade with full knowledge that they are efficient machines because they have resulted from a long period of experiments and actual use. These experiments have been continued with the idea of finding out just what these separators do under the specific conditions in which they have to operate and the design has been perfected until the makers are willing to guarantee a machine to give better than 99 per cent dry steam under any and all conditions. The importance of this matter of efficiency is shown by the fact that every 1 per cent of moisture or steam when it reaches the engine causes another 1 per cent of loss in using it and, if the engine is running at a low load, possibly 3 times that amount. It is generally agreed that in all main lines carrying wet superheated steam a film of water is likely to form around the inside of the pipe and the longer the pipe line the greater the amount of this film. In a horizontal pipe this film collects and runs along the bottom so that as soon as the steam hits the separator, the water is thrown into the current of the steam unless provision is made against that. The Strong separator for horizontal and vertical pipes takes care of this film of water and prevents it from getting into the current of steam.

All Strong separators are built in 2 sections, separation taking place in the upper half, the lower half being the water chamber. The main separating feature is a perforated cage of brass mounted on the inside of a strong frame which fits in turn the upper section of the separator. This frame holds the perforated sheet about ½ in. from the outer wall and serves to catch the water. A separate lip catches the stream of water and conducts it to the water chamber while the entrained water goes with the steam around the inner pipe and is thrown by centrifugal force against the perforated brass sheet through which it can readily pass but it cannot readily escape. The shape of the current of steam is changed and it is also subjected to a whipsnapping action which throws off any moisture left in it. At the bottom of the separating cage is an annular ring which prevents the steam from picking any water out of the water chamber below.



THE STRONG STEAM AND OIL SEPARATOR

TO FIND THE AREA OF A CHIMNEY multiply the number of pounds of coal consumed under the boilers per hour by 12 and divide the product by the square root of the height of the chimney in feet. The quotient is the proper area of the chimney in square inches at the smallest part.

THE DAVIS EXTRA HEAVY AUTOMATIC STOP AND CHECK VALVE

As the name implies, this valve is intended to prevent the back flow of steam through a main from any cause. It is made in 2 classes, the Class C being for direct operation, while the Class B is for operation by means of a pilot valve. The valve is placed in the nozzle leading from the boiler to the header, and under normal conditions does not affect the flow of steam in any way. Should the current of steam attempt to reverse, the rush of the steam will close the valve disk and hold it firmly to its seat. The valve body is of cast iron, extra heavy, to withstand high pressures, while the disk and seat are of bronze and are renewable. An oil dashpot is rigidly connected

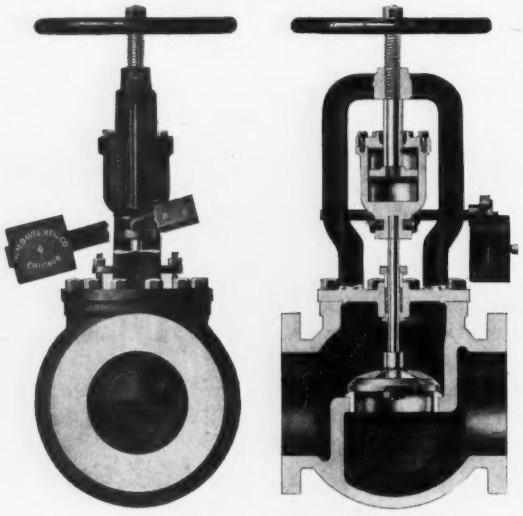


FIG. 1. SECTION AND SIDE VIEW OF DAVIS CLASS C AUTOMATIC STOP AND CHECK VALVE

to the stem to cushion the disk when seating. This dashpot is located outside the valve body and away from the action of the steam, so that the valve cannot possibly stick or get out of order.

The plunger of the dashpot is attached to the hand wheel stem while the dashpot body is attached to the disk stem. Metallic packing is used where the stem passes through the cover, giving a joint which is frictionless yet will last for years. The weighted arm gives a means for adjusting the valve to close at any desired drop in pressure.

In the Class B valve the automatic feature is the same as for the Class C and the valve will close instantly if the flow of steam attempts to reverse, but in case of accident the valve may be closed from a distant point by the operation of a pilot valve, which closes the main valve disk against the current of steam coming from the boiler. The means by which this is done are clearly shown in the section view. Other features of the valve are the same in both classes.

MONASH RADIFIER VALVE

The accompanying cut illustrates a new valve or trap being brought out by the Monash-Younker Co. of Chicago and New York, which valve when placed upon a vacuum system will constantly drain off the water condensation, oil, grease and floating sediment, thus doing away with any danger of caking or clogging of the system or valve.

In following the operation of this valve as given below, one can readily see the advantage it possesses when used on vacuum systems.

The manufacturers state that this valve can be used on vacuum systems where a pump is attached to the return end of the system, without payment of royalty.

The valve is attached to the return end of the radiator by the union nipple 1 and nut 2, and to the return pipe by threaded outlet 19. This return is connected with the vacuum pump.

The air and water of condensation are drawn by the vacuum from the radiator into the Radifier through

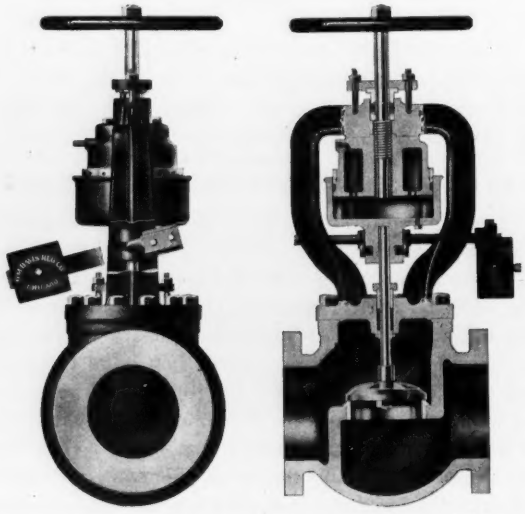


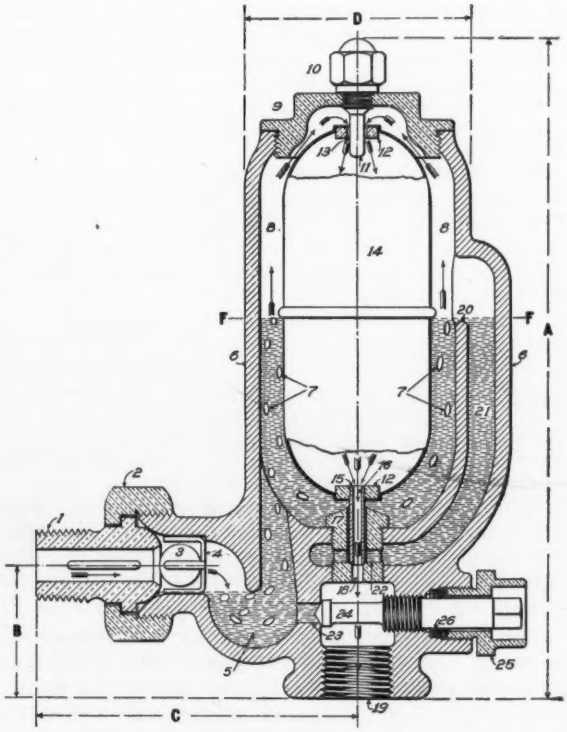
FIG. 2. DAVIS CLASS B AUTOMATIC VALVE FOR DISTANT CONTROL

the union nipple 1 past ball check 3 and down into goose neck trap 5, where any core sand or heavy dirt is deposited. Passing upward into the body 6 of the valve, the air bubbles 7 separate from the water and are drawn to the top of the body through the air space 8. Thence the air is drawn through the opening 13 in float reinforcement 12, around guide pin 11 into float 14, through the float to lower end, and out through opening 16 in outlet valve pin 15 and opening 18 in valve seat 17, thence to outlet 19 and return pipe to vacuum pump.

Water of condensation, oil, grease and floating sediment are drawn into the body of the valve, filling it to float line FF. When enough water has been drawn in to rise above float line FF, the float 14 is raised by the water, and the valve in 17 is opened. The water

then is drawn into water outlet passage 21 and through port 22 in valve seat 17 to passage 18 and outlet 19 to return pipe. When the water has been drawn off to a little below the line FF, the float drops again and valve in 17 is closed. A certain quantity of water always remains in the valve, thus preventing the discharge of any steam. Since the discharge is from the top of the water in the valve, the oil, grease and floating dirt are skimmed off, thus doing away with any danger of their caking and clogging the valve.

The phosphor-bronze ball check 3, held in place by the copper basket 4, and seating in union nipple



MONASH RADIFIER VALVE

1, prevents the vacuum in the radiator reacting on the vacuum in the return and causing the float to chatter when the radiator supply valve is closed.

Dirt or sediment deposited in goose neck trap 5 is removed by opening bypass valve 24 and drawing it out through the passage 23 to outlet 19 and return pipe. The gland 25 which compresses the packing around the bypass stem also serves as a lock shield, preventing unauthorized persons from tampering with the valve.

SMOOTH-ON TAPE

For stopping leaks in screw thread joints and in the body of a piece of pipe this invention is of the greatest value. It consists of a tape treated with the Smooth-On cement mixture, and the method of using is to apply a coat of Smooth-On elastic cement if used on hot pipes, or of Smooth-On cement No. 1 and No. 2 if used on cold pipes. The cement is forced into the opening or leak, then the joint wrapped with one layer of Smooth-On tape. The outside of this layer of tape is coated with Smooth-On cement and another wrap of tape put on, then a third coating of cement and another layer of tape, and so on. In this way a neat repair can be made which will not interfere with pipe covering.

NEWS NOTES

THE G. M. MCKELVY CO., of Youngstown, Ohio, has placed an order with the Nernst Lamp Co. for the new Westinghouse Nernst lamps for the entire lighting of its new 4-story store building, to be occupied this month.

The installation will consist of 36 3-glower lamps for the first floor, 69 2-glower lamps for the second and third floors and 75 132-watt lamps for the basement and fourth floor.

This is the largest department store in Youngstown. The building now occupied by the McKelvy Co. has been lighted by the old style Nernst lamps for several years.

STANDARD GAUGE MFG. CO., which has been actively engaged in the manufacture of indicating and recording gages in Syracuse, N. Y., will move its plant and main office to the new factory at Foxboro, Mass., about Nov. 1. By this change the manufacturing capacity will be greatly increased, as the 2 main buildings alone have 100,000 sq. ft. of available floor space besides that in the foundry, blacksmith shop, carpenter shop and power plant.

Since its beginning in 1899, the Standard Gauge Mfg. Co. has grown steadily and this development is not surprising, considering the reputation for quality which Standard gages have acquired. In the new plant there are 2 main buildings, each 60 by 210 ft., 3 stories and basement. The main power plant is a 2-story brick building located between the 2 main buildings and has an equipment of 3 Harris-Corliss engines, 4 Roberts return tubular boilers of 500 hp. each, and auxiliary apparatus which goes to make up a modern power plant. A 2-story carpenter shop 42x30 ft., a forge and blacksmith shop 42x38 ft., and a brick foundry 150x60 ft., are included in the plant. The sales office addresses will be the same as heretofore, 1770 Hudson Terminal, New York, and 752 Monadnock Building, Chicago.

A NEW SCHERZER BASCULE SPAN at Cleveland, O., was built this year, by the New York, Chicago & St. Louis Railway, across the channel of the Cuyahoga River, having a total length of nearly 3000 ft. and about 60 ft. high, the rolling lift span across the river channel being 70 ft. above the water.

This bascule span is a double track single-leaf throughout bridge, 160 ft. long, center to center of bearings, and 29 ft. 6 in. wide, center to center of trusses. The clear channel for navigation allowed by the new bridge, is 120 ft., measured at right angles to the channel, the bridge crossing the river at an angle of about 62 deg.

The bridge is operated by 2 direct current electric motors of 50 hp. each. There is also a 9 hp. Fairbanks-Morse gasoline engine auxiliary, to operate the bridge should there be any trouble from defective current or electrical equipment. This 9 hp. engine will lift the bridge in 12 min., doing the work of 2 50-hp. electric motors in case of a breakdown.

EXAMINATION WILL BE HELD on Nov. 25 for office engineer in irrigation and drainage investigations. Sal-

ary $1200 to $2000 a year; education and experience required in general agriculture, irrigation and hydraulic problems, office routine and executive duties. Age 21 yr. or over. Application to be made on Form 1312, which may be had from the U. S. Civil Service Commission, Washington, D. C.

PRESIDENT W. H. WHITESIDE'S REPORT of the business of the Allis-Chalmers Co. for the year ending June 30, 1908, shows total earnings after paying the cost of manufacturing, selling, taxes, insurance, general expenses, fixed dividends and doubtful accounts of $2,573,960.03. Deducting charges for repairs, maintenance and renewals on plant, reserves for depreciation, interest on bonds and notes and a special reserve to allow for shrinkage in collection of bills, a net earning remains of $615,814.24.

For the last quarter of 1907 and the first quarter of 1908 the volume of sales averaged half the normal; but for the second quarter of 1908 there has been a gradual, steady increase in orders booked.

AT AUSTIN, TEX., in the Water Works Electric Light and Power Co. of that city, the power facilities have become inadequate and a new steam turbine generating unit furnished by the Allis-Chalmers Co., of Milwaukee, is being installed. At the present time a 400-hp. tandem compound engine is used to furnish current and the load frequently becomes so great as to require transferring part of it to an 800-hp. used to drive a number of small dynamos. The small dynamos are driven from a large steel shaft which in turn is driven from the engine by a rope drive. The installation of the turbine unit will do away with the necessity of this transfer, increase the efficiency of the plant and materially reduce operating expenses.

FITCHBURG STEAM ENGINE CO., of Fitchburg, Mass., has recently closed contracts for engines to be used in the La Salle Hotel, Chicago, and in the new Fifth Avenue building, New York City.

OF PERSONAL INTEREST

L. B. MARKS AND J. E. WOODELL have opened an office as consulting engineers in the Terminal Building, Park avenue and 41st street, New York. Their work will include generation, distribution and application of electric current for light, heat and power.

D. C. AND WM. B. JACKSON, who conduct a general consulting engineering business, have removed their western office from Madison, Wis., to the Commercial National Bank Building, Chicago. Wm. J. Crumpton will be in charge of that office.

FRANCIS W. HOADLEY, formerly assistant to the secretary of the American Society of Mechanical Engineers, has been elected secretary and treasurer of the Cassier Magazine Co., and is now to be found at the offices of that company, 12 West 31st St., New York City.

HARRY PENNINGTON, Lumbermen's National Bank Building, Houston, Texas, announces that he has been appointed Texas agent for the Wheeler Condenser & Engineering Co., of Carteret, N. J., manufacturers of the Wheeler surface, jet and barometric condensers, and Wheeler centrifugal pumps, Wheeler-Barnard water cooling towers, Wheeler-Edwards patent air pumps and other lines manufactured by this company, such as feed-water heaters, vacuum pans, exhaust relief valves, etc. Mr. Pennington has been engaged in the practice of mechanical engineering in Houston for a number of years, and has been identified with many of the large enterprises in that section, having had charge during the past 7 years of engineering construction work, costing over $2,500,000. He is at present consulting engineer for the Galveston Water Works, engineer for Houston and Fort Bend Counties, president of the Southwestern Engineers' and Architects' Clubs and chief engineer officer of the State of Texas.

SOCIETIES

AT THE LAST MEETING of the Missouri Manufacturers' Association, J. A. J. Shultz, president of the Shultz Belting Co., manufacturers of Shultz Sable Rawhide belting, and Shultz Aqua water-proof belting, and other lines, was elected president of the Association. This is a Missouri State Association with headquarters in St. Louis.

THE NOVEMBER MEETING of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th street, on Tuesday evening, November 10. Mr. Franklin Phillips, president of the Hewes & Phillips Iron Works, Newark, N. J., will make an address on The High Powered Rifle and its Ammunition-Instruments of Precision, illustrated by lantern slides.

Mr. Phillips is an expert marksman, and in 1903 won the position as first alternate on the International Rifle Team to England. He was for many years chairman of the committee on Rifle and Pistol Practice in the National Guard of New Jersey and is now Ordnance Officer of the Second Infantry of that state.

Tests of rifles and ammunition at Sea Girt, N. J. by men connected with the N. J. National Guard have led to marked improvement in arms and ammunition and to an entire change in the powder used by the government, thereby greatly increasing the accuracy of the shot. The improvement has been extended to large guns and instead of 2 per cent hits which were made at Santiago, 80 per cent is now the average in some ships.

Mr. Phillips has actively participated in this work and as he is primarily a mechanical engineer, as well as a marksman, he will explain to his audience the practical bearing of his investigations upon the construction of arms and the elements entering into ammunition.

THE CONVENTION ON THE SUBJECT OF Promotion of Industrial Education will be held in Atlanta, Nov. 19-21, with headquarters at the Piedmont Hotel. An Exhibition of work by pupils of trade schools will be arranged at the state capitol and the topics considered at the different meetings will be: Industrial Education and National Prosperity, Industrial Training through the Apprenticeship System, Trade Schools, and the Moral and Material Benefits of Industrial Education, and Industrial Education in the Public Schools.

OF INTEREST TO THOSE ENGAGED in the manufacturing and sale of gas and gasoline engines and accessories thereto will be a call issued by M. A. Loeb, secretary and treasurer of the Rock Island Battery Co., for a meeting at the Auditorium Hotel, Chicago, Wednesday, Dec. 9, 1908, at 10 a. m. The object of this meeting is the discussion and formulating of plans for forming an association of manufacturers and dealers in gas and gasoline engines and accessories and the trade press devoted to these interests. It is desired that this organization should be perfected at the first meeting, officers elected and committee appointed to arrange for a national convention to be held at some later time, the time and place to be arranged by the executive committee of the organization.

THE EVAPORATION OF 10 POUNDS of water per pound of coal is seldom exceeded in practice.

CATALOG NOTES

ON AN ATTRACTIVE MAILING CARD, which is used for answering minor correspondence, the L. S. Starrett Co., of Athol, Mass., shows its factories, which make up the largest plant in the world devoted exclusively to the production of small tools for mechanics and contain over 4 acres of floor space.

THE 22ND EDITION of The Murphy Automatic Smokeless Furnace, the attractive and instructive catalog issued by the Murphy Iron Works of Detroit, shows that the interest in this apparatus is great or 21 editions would not have been used up. Looking over the catalog, one is not surprised; it is a worthwhile book.

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO., of Philadelphia, has devised an attractive folder entitled "Waiting." What you are waiting for is explained on the inside of the folder. You can find out by writing to the company.

FROM C. H. WHEELER MFG. CO., of Philadelphia comes a handsome catalog, Bulletin No. 9, illustrating the principal designs of pumps, condensers, feed-water heaters and cooling towers which the company designs, manufactures and installs.

DIRECT CONNECTED GENERATING SETS made by the General Electric Co. are fully described in Bulletin 4617 for August, 1908.

STANDARD MULTIPHASE SWITCHBOARD PANELS made by the Fort Wayne Electric Works is the title of Bulletin 1110 issued by that company which fully describes the apparatus. Motor Drives are also treated fully in Bulletin 1111.

WILE GAS PRODUCERS for non-bituminous fuels form the subject of a pamphlet sent out by the Gas Machinery Co. of Cleveland, O.

THE ORGAN FEED WATER HEATER AND PURIFIER is of the open type having oil separator, filter, steam trap and sediment trays. Its construction is fully described in the catalog of Thomas O. Organ of Philadelphia, the maker.

BOILER TROUBLES AND THEIR PREVENTION is the title of a 48-page treatise just issued by the Bird-Archer Co. This book will interest all who own or operate steam boilers, for it explains corrosion, scale, oil and grease deposits and what harm they may do. It tells what scale consists of, how it collects, resulting loss in fuel and steaming capacity, dangers from overheating, cost of mechanical cleaning and the advantage of boiler compounds in preventing scale, oil deposit or corrosion. It further discusses every method of water and scale treatment, gives valuable advice on feeding boiler compounds, the care of blow-off valves, etc. Copies may be had free by addressing the Bird-Archer Co., 90 West St., New York.

FISHER GOVERNORS are fully described in a new catalog just issued by the Fisher Governor Co., Marshalltown, Iowa. The catalog gives dimensions, shipping weights and prices on the angle and globe pattern, these governors being made for control by spring, by gravity, by vacuum and by electric current. The Fisher reducing valve is also described and illustrated.

SCULLY'S STOCK LIST for October, issued by the Scully Steel & Iron Co., has full dimension and price lists of all kinds of round, flat and other shaped bars, structural steel, bolts, screws and nuts, boiler braces, washers, flanges, staybolts, punches, drills and reamers, wrenches and rivets, and all other standard material needed in the construction of boilers, tanks and plate work.

A. ALLAN & SON, 486 Greenwich St., New York City, have issued their second bulletin on the Allan Anti-Friction Metal. It treats of the use of Allan Metal for piston packing and for piston rod packing, showing with full detail just how rings of this metal can be applied to advantage ,and giving instructions by text and illustration of the way to go about it. The booklet in itself is an attractive piece of work and the subject with which it deals is important. It can be had on request to the company.

MONARCH FIRE DOOR and back combustion chamber arches which are made of a combination of cast iron and firebrick and manufactured by the Mayville Specialty Mfg. Co., of Mayville, Wis., are described in a booklet just received. These arches are manufactured for boilers of all sizes and are a great convenience in the operation of a boiler.

BROCHURE NO. 98 is ready in the 1908 special edition. It's all about a number of recent gas power installations made by the Weber Gas Engine Co. in mills, factories, water works and electric light plants. Short clear descriptions, good illustrations of bituminous and non-bituminous producers, artistic design and attractive printing are happily combined. A request will bring a copy.

FROM ENGBERG'S ELECTRICAL AND MECHANICAL WORKS, St. Joseph, Mich. comes an attractive pamphlet describing small direct connected gas engine generating sets.

GOULDS PUMPS for every service are made by the Goulds Mfg. Co., of Seneca Falls, N. Y., which describes in a neat booklet just issued, hand force pumps for house and mill service. Other pamphlets are issued which describe all kinds of power pumps.

THE OLD ESTABLISHED FIRM of Thos. C. Warley & Co., manufacturer of Warley's Boiler Cleansing Compounds, located at 221 South Front St., Philadelphia, Pa., is sending out to engineers a useful book entitled Twentieth Century Examinations for Engineers, etc. The book is full of practical questions and answers; it is neatly bound with a red cover, and will be of value to every engineer.

AS DIRECT CURRENT cannot be readily generated at or transformed to high voltages, such as economical distance distribution dictates, alternating current is almost invariably used for all except very small or compact electric power transmissions. Wherever direct current is used in operating, however, the alternating current must be transformed. While, of course, this can be accomplished by means of a motor generator set, the higher efficiency and lower cost of the rotary converter accounts for its almost universal use on low frequencies.

The rotary converter manufactured by Allis-Chalmers Co. has many features of paramount importance to the engineer which are explained in the company's bulletin No. 1045 sent on application.

REYNOLDS CORLISS HEAVY DUTY ENGINES are illustrated and described in Allis-Chalmers Bulletin No. 1510. Among those illustrated are the largest engines ever built for direct connection to electric generators used in the Manhattan and Subway stations of the New York City Railway.

WESTERN ELECTRICAL AND GAS DIRECTORY. The latest edition of this book contains 1021 electrical, gas, railway and light companies operating in the states of Arizona, California, Nevada, Oregon and Washington, with many details of information in regard to the companies and their organization. Six hundred and eighty-six companies are engaged in generation and transmission of current for electric light and power, 145 in gas and 190 in electric railways. The directory is arranged by names of companies with the individuals under each company. The list is also arranged alphabetically by the cities and towns under their respective states and also under the industry or industries which they may represent. The companies which are independent and those which are dependent are indicated. The price for paper cover is $10.

MASON SERVICE FOR MILLS AND FACTORIES is a booklet issued by the Mason Regulator Co., of Boston, Mass., and describing the Mason devices, which include reducing valves, damper regulators and pump pressure regulators.

G. C. ST. JOHN, of New York, has succeeded in adapting his meter so that it is now suitable for the indicating and recording of the flow of air as well as of steam. The new device is in every way as accurate and convenient as the St. John steam meter. It is described in a special catalog just issued by Mr. St. John.

ASBESTOS PROTECTED METAL CO., of Canton, Mass., has produced a product consisting of sheet steel coated on both sides with asbestos felt. Beneath the asbestos is a layer of an asphaltum compound which gives a permanent seal against the action of moisture on the metal and holds the asbestos coating to the sheet. The asbestos surface on both sides gives a covering which will not burn or decay, and which protects the asphalt compound from heat and cold. The material is fully described in a pamphlet just issued by the company.

HESS-BRIGHT BALL BEARINGS are described and illustrated in a catalog just sent out by the Hess-Bright Mfg. Co., of Philadelphia.

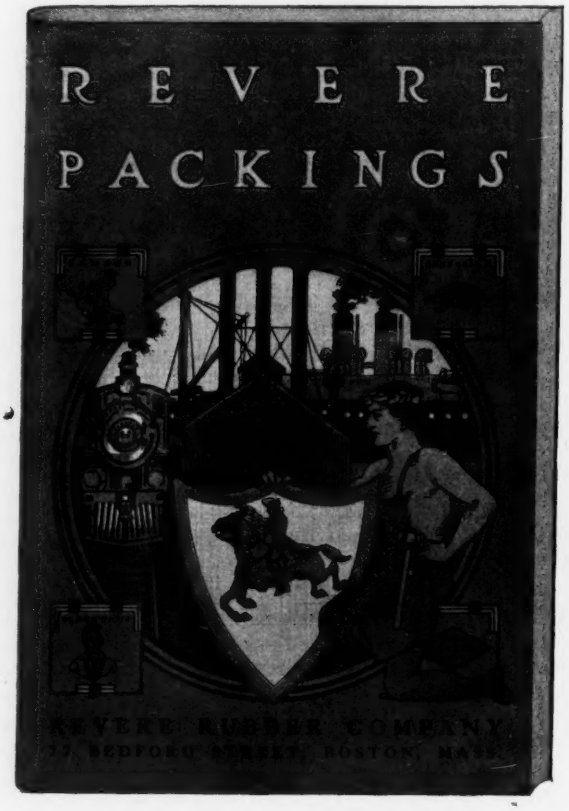
GLACIER METAL CO., 116 Broad St., New York, is issuing a new catalog describing its metal for bearings of all kinds. The qualities of the metal are stated, the results of tests are given, and the different applications of the metal are illustrated.

BURT MANUFACTURING CO., of Akron, Ohio in a folder on the subject of ventilation gives the adantages of using its combination skylight ventilators

There is a general tendency toward the illumination of the streets of residential districts by means of the series incandescent system of lighting, the consensus of opinion being that units of low intensity distributed at frequent intervals form the ideal system for this service. The principal objection to this system, namely, the low efficiency of the available lamps, has been eliminated by the introduction of the series Tungsten lamp which has an efficiency of 1½ watts per candle power. A series system utilizing Tungsten lamps is fully described in Bulletin No. 4607, just issued by the General Electric Company, Schenectady, N. Y. This description includes illustrations and general data on transformers, switchboards, lamp brackets and reflectors, series sockets and lightning arresters, used in connection with the system.

The favor with which Swartwout steam specialties are being received is shown by the ever increasing orders for the equipment of school buildings. Among recent orders are those from the following: Exhaust heads for the Pana High School Building, Pana, Ill.; High School Building, Beloit, Wis.; East High School, Minneapolis, Minn.; Lincoln School Building, Fort Dodge, Ia.; 1 10-in. exhaust head and 2 steam separators for Technical High School, Cleveland, Ohio; and an oil separator for Piqua High School Building, Piqua, Ohio.

ATTRACTIVE AND BEAUTIFUL are 2 of a whole string of adjectives that might properly be applied to the new catalog of the Revere Rubber Co., of Boston, Mass. The first thing to attract attention



is the handsome embossed cover design showing the trade marks of 3 styles of the packings manufactured, and the shield with Paul Revere on his famous ride, which is the trade mark of the company. Inside, each page is surrounded by a colored border; after a general discussion of the materials and qualities of packing, each style handled by the company is illustrated and fully described, including sheet, square and round, spiral, valve stem, diagonal, hydraulic, combination, ammonia, pump, metallic insertion, gasket, pump valves and gage glass rings. The catalog is well worth having, either as a piece of fine printing or as a book chock full of good engineering information.

SEAMLESS TUBE CO. OF AMERICA, located in Pittsburg, Pa., has developed a line of tubing which stands most unusual tests. The material is guaranteed in every respect and the price-lists and dimension lists of the different kinds of tube made, together with considerable information and many tables of data, are included in a couple of pamphlets, one on the subject of Tubes for Mechanical Purposes, the other on Seamless Boiler Tubes, just issued by the company.

AUTOMATIC WATER SOFTENER AND SCALE REMOVING DEVICES are described in Catalog No. 10, issued by the Compound Injector & Specialty Co., of Chicago, Ill. These devices are intended largely for the scale removing and water softening in connection with domestic plants, restaurants, laundries, etc.

MAGIC METHODS is the title of a booklet just issued by the H. W. Johns-Manville Co., of New York City. The Magic Method is for cleaning the scale from boilers and is by the use of the Magic Boiler Compound, which is stated to form a coating over the surface of iron or steel in the same way that cylinder oil coats the sides of an engine cylinder. The booklet contains a number of interesting statements in regard to the action of this new material.

ALLIS-CHALMERS CO.'S Corliss engines are equipped with many parts which appeal very strongly to operating engineers and information on such details is always in demand. The valve gear of these engines has a new steel detaching device which does not show excessive wear, due to operation. Wear often becomes so great in inferior types of construction that the pin will loosen with running and serious results follow. This difficulty and others incident to the older style are eliminated by the new arrangement, which is described in Allis-Chalmers Co.'s Bulletin 1505, sent on request. Another highly desirable feature in the valve gear and regulator is to be found in the safety stop. This consists of blocks of steel on the cutoff cams which come into position and shut off the steam should the governor belt break. An automatic arrangement is also provided so that these blocks are inoperative when the engine is starting.

BULLETIN NO. 1 of the Standard Gauge Mfg. Co., of Syracuse, N. Y., is most useful and interesting. It deals, not with gages, but with Eclipse oil filters and filtering systems, and shows the regular uses, special applications, details of construction and principles of operation. Dimensions, capacities and prices are fully stated on round and square filters, storage tanks, oil pumps and fittings. From the arrangements shown can be worked out a system suitable for almost any plant.

F. S. WALTON CO., of Philadelphia, in a pamphlet describing its Ox-Oil-Ox belt dressing and preservative, tells of the composition and gives a number of flattering testimonials as to the effectiveness of the dressing.

THE HAMBURG MFG. CO., of Hamburg, Pa., which was organized last fall to build New Century chain hoists, established a modern plant at Front and Washington Sts. in that city, and now reports a good run of trade. Recent shipments on rush orders are 15 2-ton hoists to a large Ohio rubber company and 53 hoists to the Mare Island navy yard at San Francisco.

IN PAMPHLET NO. 081, C. W. Hunt Co. gives an introduction to its general line of labor saving machinery, including conveyors, tower hoists, railways, rope haulage, coal storage and electric locomotives.

HODGE BOILER WORKS, of Boston, Mass., which was founded in 1865, is issuing a large and handsome catalog giving the standard sizes of return tubular boilers, illustrating different styles made by them, giving a standard form of specification for horizontal tubular boilers, dimension drawings for the setting of such boilers, and descriptions of plans of different types of boilers, of grate bars and of boiler accessories. The book has 100 pages with many tables of value as well as the descriptive matter.

IN CATALOG LITERATURE which it is now sending out, the Goheen Manufacturing Co., Canton, Ohio, gives the results of some tests made by Prof. W. T. Magruder, of the Ohio State University, on the spreading power of paints, which the company manufactures, and the cost to paint 100 square feet of steel plate.

BULLETIN NO. 4600, recently issued by the General Electric Co., describes various types of controllers for use in connection with both alternating and direct-current motors, on electric cars, locomotives, automobiles, launches, elevators, trains, hoists, etc., and also in rolling mills, machine shops, printing plants and pumping stations. The bulletin describes the controller most suitable for a specific purpose. It contains general data and dimensions which will be found of value to anyone contemplating the installation of motor drive.

METALLIC PACKING is the sole product of the C. Lee Cook Mfg. Co., of Louisville, Ky. These packings are made in all sizes for all services, and the descriptions and illustrations contained in the catalog just issued by that company are complete and interesting. A postal brings one.

TRADE NOTES

WRITING TO THE F. S. WALTON CO., of Philadelphia, the secretary of the Heisler Locomotive Works, of Erie, Pa., says: "Replying to your favor of the 28th inst. in regard to belt dressing, will say that we have tried out the sample sent us and find it very satisfactory, and will favor you with our future orders."

WALTER D. CARPENTER CO., of New York City, in response to a large demand, is putting on the market a new Graphlio compound. This is a grease ready mixed with the Graphlio and is intended for those places where great heat, extreme cold and high pressure make this form of lubricant desirable. It is a product which will be likely to solve a good many lubricating problems.

THE ARCTIC ICE MACHINE CO., of Canton, Ohio, under date of Sept. 29, 1908, writes to Greene, Tweed & Co., 109 Duane St., New York City, as follows: "You may be interested to know that we have used quite extensively during the past season your latest improved Rochester automatic lubricators for supplying oil to ammonia compressor stuffing boxes, which is most difficult to do, and not in a single instance have we had a complaint, but, on the contrary, our customers have frequently spoken well of the lubricators, and we must conclude what is satisfactory to them should be, and is satisfactory to us. We have accordingly made arrangements to equip our entire line of ice making machinery for the coming season with the 'Rochester.'"

FROM THE MICHIGAN CONDENSED MILK CO. factory at Frankfort, N. Y., comes a letter to The Buckeye Boiler Skimmer Co., Toledo, O., stating that: "We are so well pleased with the floating skimmers which you installed in our Babcock & Wilcox boilers at our Mt. Pleasant, Mich., factory, that we take pleasure in saying, that after 3 months of hard work, we opened one of the boilers to see how it looked and found no mud and practically no scale,

everything is just as you stated, the cost of using them is so small it would be impossible for us to figure it, which means practically nothing.

"We are quite confident if any concern who is bothered with scale or mud in boilers, will give your floating skimmers a trial, they will speak as highly of it as we do."

THE CHERRY CHEMICAL CO., which manufactures Red Seal boiler compound, wants good agents to represent this product in all territory. Oliver Braden, the manager, has been connected with this company since it started 15 years ago and is thoroughly familiar with the business and can not only make good boiler compound, but can post agents on all points in regard to it. The Cherry Chemical Co. makes analyses of scale and feed water for customers without charge and gives a written opinion in regard to the compound and what it will do. The goods are sold under absolute guarantee. This seems a chance for good men to get permanent positions. Full information can be had by writing to the Cherry Chemical Co., 1018 Callowhill St., Philadelphia, Pa.

QUICK WORK IN TAKING INDICATOR DIAGRAMS is sometimes of great advantage, and when this is necessary an indicator that helps out is of the greatest convenience. In writing to the American Steam Gauge & Valve Mfg. Co., Chas. S. Lynch, naval architect and engineer, gives the advantages which the American-Thompson Improved indicator has for quick work, and shows 5 cards which were taken on a marine engine in 61.5 seconds, which is certainly fast going. The details of this performance are given in a folder which can be had on application to the American Steam Gauge & Valve Mfg. Co., Boston, Mass.

THE NELSON VALVE CO. reports that it is behind in its orders and that the demand for Nelson Valves has compelled another enlargement of the plant.

About a year ago the Nelson Valve Co. increased its capacity nearly 100 per cent; it has now been compelled to again increase and has secured 2.5 acres additional, on which a modern new shop 200 ft. long has been erected, equipped with new and modern tools. The management is contemplating the erection also of a 100-ft. addition to its brass foundry, which will be equipped with oil furnaces and power moulding machines of the latest type.

RECENT SALES MADE BY The Ohio Blower Co., Cleveland, Ohio, include Swartwout cast iron exhaust heads to the following parties: Central Kentucky Asylum, Louisville Ky., 1 14-in.; C. & N. W. R. R. Chicago, Ill., 1 12-in.; Foster Merriam & Co., Meriden, Conn., 1 10-in.; H. Murdock & Co., Fredericktown, Pa., 2 10-in.; West Kentucky Asylum, Louisville, Ky., 1 10-in.; Richmond Chemical Works, Richmond, Va., 1 10-in.; Birmingham Coal & Iron Co., Mulgay, Ala., 2 9-in; Geo. F. Whiting, Baltimore, Md., 1 8-in.; Bethel Hat Forming Co., Bethel, Conn., 1 6-in.; Florida East Coast Railway, St. Augustine, Fla., 1 6-in.; Augustana Hospital, Chicago, Ill., 1 6-in.; The Southern Pacific Railway Hospital, San Francisco, Cal., 1 6-in.; S. Horvitz & Co., Cincinnati, Ohio, 1 6-in.; others to Amherst Supply Co., Amherst, Ohio; Illinois Steel Co., Chicago, Ill.; The American Thread Co., Milo, Maine; Chas. Wilkins & Co., Minneapolis, Minn.; Shapley & Wells, Binghamton, N.Y. Swartwout Steam Separators have been sold to Richmond Chemical Works, Richmond, Va.; F. A. Bickle, Sandusky, Mich.; Northern Pacific Ry. Co., Paradise, Mont.

WANTED

"Positions Wanted" advertisements not exceeding 50 words for subscribers to Practical Engineer will be inserted twice free of charge. "Help Wanted" and special advertisements 25 cents a line.

FOR ENGINEERS

The new revised edition of the Modern Engineer's Hand Book. A $2.50 Book by mail on receipt of 50 cents. Be quick. Address, W. H. Ermentrout, 514 Elm Street, Reading, Pa. 4 tf

FOR SALE

60 steel storage tanks, 6,000 gallons' capacity. Good as new. Double riveted, extra well built. Suitable for storage of oils, waters or liquids of any kind. 100 steam pumps. Get our prices on engines, boilers and electrical machinery. All sizes and kinds. Chicago House Wrecking Co., 35th and Iron Sts., Chicago. 4 tf

FOR SALE

Complete steam engineering course in International Correspondence Schools, brand new, cost seventy-five dollars. What will you give? For particulars address W. L. D., Lock Box L. Valley Falls, R. I. 10-1

ENGINEERS AND MECHANICS

To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-1

PATENTS

C. L. Parker, Late Examiner, U. S. Patent office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4 tf

PATENTS

Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4 tf

SALESMAN

We want a good Salesman in every city in the United States, to handle Ideal Metallic Packing. Manufacturers' Agents and Engineers preferred—Ideal Metallic Packing Co., South Stillwater, Minn. 4 tf

SALESMEN WANTED

To introduce our New Commercial and Statistical State Chart for office and general use. The work is congenial and profitable, the earnings being according to your ability. A thorough training is given before the work is started. Rand, McNally & Co., Chicago, Ill. 10-5

WANTED

Engineers, Firemen, Electricians, Machinists, etc. New 25-page pamphlet containing questions asked by Examining Boards sent free upon request. Address, Geo. A. Zeller Book Co., 4467 W. Belle Place, St. Louis, Mo. Established 1870. 4 tf

WANTED

To sell rubber name stamps. Send for circulars. Address Albert B. Howard, Cheshire, Ohio. 10-1

POSITION

By engineer with twenty years' practical experience with all makes and types of engines and boilers. Am strictly temperate, hold a first-class engineer's license in Mass. Will go anywhere Maine, Vermont or New Hampshire preferred, for $21.00 per week, or better. Address Box 87, care of Practical Engineer. 10-1

POSITION

By engineer with 15 years' experience in manufacturing and power plants. At present chief of large manufacturing concern's power plant. Will be at liberty December 1st and desire a position in Pacific Coast States. Address Box 88, care of Practical Engineer. 10-2

POSITION

As chief engineer or assistant. Age 32. Holding chief engineer's marine license, and also stationary license. Have had eight years' experience, four years in electric light and power station. Address L. W., Ossining, N. Y. 10-2

POSITION

As engineer. Have had twenty years' experience, understand all kinds of engines and can do all manner of pipe fitting and electric wiring. Will accept a good first position of firing or as second engineer. Address Box 84, care of Practical Engineer. 9-2